DOCUMENT RESUME

ED 157 681 SE 022 840

AUTHOR	Tully, Randolph R., Jr., Ed.
TITLE	A Curriculum Activities Guide to Electric Power Generation and the Environment.
INSTITUTION	Project KARE, Blue Bell, Pa.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C.
PUB DATE	75
GRANT	OEG-71-1775
NOTE	154p.; For related documents, see SE 022 841-842
AVAILABLE FROM	Project KARE, Colony Office Bldg., Route 73 & Butler Pike, Blue Bell, Pa. 19422 (no price quoted)
EDRS PRICE	MF-$0.83 HC-$8.69 Plus Postage.
DESCRIPTORS	Curriculum Guides; *Elementary Secondary Education; *Energy Conservation; *Environmental Education; *Instructional Materials; Learning Activities; Natural Resources; Science Activities; Science Education; Teacher Developed Materials; Values
IDENTIFIERS	Project KARE

ABSTRACT

This guide was developed by teachers involved in a workshop on "Electric Power Generation and the Environment." Activity topics are: (1) Energy and the Consumer; (2) Energy and Water Pollution; and (3) Energy and Air Pollution. Within these topics, the activities are classified as awareness level, transitional level, or operational level. Each activity contains an introduction, questions, equipment list, and procedure. There are over 70 activities for students in grades 1-12. The appendix provides a brief description of the development of the learning activities in this guide. (MA)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

June Katucki

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM."

SE

ED157681

SE 022 840

BUCKS · MONTGOMERY · CHESTER · PHILADELPHIA · DELAWARE

A CURRICULUM ACTIVITIES GUIDE

Project

KARE

A National Model for Strengthening Environmental Studies in Local Schools

TO ELECTRIC POWER GENERATION AND THE ENVIRONMENT

A CURRICULUM ACTIVITIES GUIDE TO ELECTRIC POWER GENERATION AND THE ENVIRONMENT

Edited by
RANDOLPH R. TULLY, JR.
ENVIRONMENTAL SPECIALIST
PROJECT KARE

PROJECT KARE
MONTGOMERY COUNTY INTERMEDIATE UNIT
COLONY OFFICE BUILDING
RT. 73 & BUTLER PIKE
BLUE BELL, PA. 19422

PROJECT KARE STAFF:
MATTHEW M. HICKEY, DIRECTOR
ALAN D. SEXTON, ASSISTANT DIRECTOR
RANDOLPH R. TULLY, ENVIRONMENTAL SPEC.
JANET A. HYLAND, ADMINISTRATIVE ASST.

The project presented or reported herein was performed pursuant to a Grant from the U.S. Office of Education, Department of Health, Education, and Welfare. However, the opinions expressed herein do not necessarily reflect the position or policy of the U.S. Office of Education, and no official endorsement by the U.S. Office of Education should be inferred.

The materials in this book were written and compiled during 1975 under the grant No. OEG-71-1775 from the Department of Health, Education, and Welfare, Office of Education, Washington, D.C. 20202.

Information concerning this publication may be obtained from:

PROJECT KARE
Colony Office Building
Route 73 & Butler Pike
Blue Bell, Pennsylvania 19422

FIRST PRINTING 1975

Copyright pending

This document is printed on 100% recycled paper.

PREFACE

The activities in this book were produced by the participants in the course, "Electric Power Generation and the Environment". The sponsors of the course were the Montgomery County Intermediate Unit, the Montgomery County Intermediate Unit In-Service Council, the Montgomery County Science Teachers Association, the Philadelphia Electric Company, and Project KARE. Instructors for the course were provided by the Philadelphia Electric Company and Project KARE.

As one requirement for receiving In-Service credit, all the teachers were asked to write activities which they intended to use with their own classes. These activities were to deal with the topics of "Energy and the Consumer", "Energy and Water Pollution", and "Energy and Air Pollution". Their first introduction to the writing format and topics came only four days before the finished product was due. Consequently, some variety in their presentation may be noticed. Our intent is not to provide the final word in energy-related curricula. Rather, our hope is to suggest directions, provide a few examples, and encourage creativity. Comments made by the instructors will be found in upper case letters at the end of each activity. In the Appendix is some background and supportive material. Included in it are: a description of the USOE National Diffusion Network and Project KARE, a brief description of the course, a schedule of sessions and instructions (as given to the participants) for writing activities.

ACKNOWLEDGEMENTS

We are grateful to Dr. Dennis Harken, Executive Director, Montgomery County Intermediate Unit #23, for making the expertise of the Intermediate Unit staff available to us during the planning, conducting, and follow-up phases of the course. Mr. Louis A. Krug and Dr. Donald Wright very ably represented the Intermediate Unit and worked in liaison with the Montgomery County Intermediate Unit In-Service Council for approval of the course.

Through Mr. John Kostige, the Montgomery County Science Teachers Association was instrumental in the original development and direction for the course.

Special thanks go to Mr. Mike McCormick of the Philadelphia Electric Company for his efforts during the planning of the course, for providing many of the instructors, for coordinating field and indoor meeting facilities, and for locating numerous free materials for the course participants. Thanks also to Mr. Larry Eckman for hosting us each day, for ably guiding our field trips, and for the daily doughnuts.

The typing skills and perserverance of Mrs. Bette Pasquarello and Miss Janet Hyland greatly aided the editor in the preparation of this book.

COURSE PARTICIPANTS

Participant	School	School District
Penny Baker	Vineland State S.	Vineland, N.J.
Betty F. Cheater	Ogontz Jr.H.S.	Cheltenham S.D.
Nancy Constanzer	Hatfield El.S.	North Penn S.D.
Robert L. Ewart	Lower Moreland Mid.S.	Lower Moreland S.D.
James G. Gill, III	Souderton Area H.S.	Souderton Area S.D.
Otis J. Guinyard	Gotwals El.S.	Norristown Area S.D.
William F. Hargardon	Perkiomen Valley H.S.	Perkiomen Valley S.D.
Gary L. Hartman	Souderton Area Sr.H.S.	Souderton Area S.D.
Barrie Herbert	North Penn Sr. H.S.	North Penn S.D.
Christine Hoch	Pennfield Jr. H.S.	North Penn S.D.
Annarae B. Krouse	Upper Moreland Sr.H.S.	Upper Moreland S.D.
Paul W. Larson	Lower Moreland Mid.S.	Lower Moreland S.D.
Ellen Lebow	Harriton H.S.	Lower Merion S.D.
R.A. McArthur	Plymouth Jr. H.S.	Colonial S.D.
James Millhouse	North Penn H.S.	North Penn S.D.
David A. Nelson	North Mont.Co.Vo-Tech.	Montgomery Co. I.U.
Barbara Quinn	Three Tuns Jr.H.S.	Upper Dublin S.D.
W. Thomas Riley	Upper Darby Sr. H.S.	Upper Darby S.D.
Barbara E. Ritter	Three Tuns Jr.H.S.	Upper Dublin S.D.
Donald B. Scholl	Plymouth-Whitemarsh Sr.H.S.	Colonial S.D.
Pamela Shearon	Sandy Run Jr. H.S.	Upper Dublin S.D.
Ronald Shenberger	Upper Perkiomen Sr. H.S.	Upper Perkiomen S.D.
Jim Weaver	Indian Crest Jr. H.S.	Souderton Area S.D.
Cheryl A. Wheeler	Gotwals & Roosevelt E.S.	Norristown Area S.D.

COURSE INSTRUCTORS

Instructor	Affiliation
W. Alden	Philadelphia Electric Company
H. L. Bermanis	United Engineers & Constructors
Paul Harmon	Ichthyological Associates
Ronald L. Harper	Philadelphia Electric Company
G. Hunger	Philadelphia Electric Company
Steve Kim	Radiation Consultant
Alan D. Sexton	Project KARE
Randolph R. Tully	Project KARE

TABLE OF CONTENTS

	Page No.
ENERGY AND THE CONSUMER.....	1
ENERGY AND WATER POLLUTION.....	48
ENERGY AND AIR POLLUTION.....	97
APPENDIX.....	139

NOTE: - Comments of the instructors appear in upper case.

ENERGY AND THE CONSUMER

Page No.

AWARENESS LEVEL ACTIVITIES:

Using Energy-Everyone, Everyday..... 3
I Feel Tired..... 5
Energy Cycle..... 7
Studying Light Bulbs..... 9
Water and Energy Wastes From a Leaky Faucet..... 11
Serigraphy..... 13
Kilo-What?..... 14
Consumption--Pollution?..... 16
Home Use..... 18
Everybody Uses It..... 20
Whose Crisis?..... 22
Rising Appliances..... 23
Black-Out!..... 24
Dependence Grows..... 26
Dealing With Packaging..... 27
Energy Costs..... 29
$$$$$$..... 30
Conservatism in Consumerism..... 31
Energy and the Apple..... 33
Sources of Energy in the Classroom..... 34
The Electric Meter and Your Pocketbook..... 36

TRANSITIONAL LEVEL ACTIVITIES:

Why Are Those Electric Bills So High?..... 39
Generating Electricity..... 41
It All Adds Up..... 43
House Current..... 44

OPERATIONAL LEVEL ACTIVITY:

Another Rate Increase?..... 47

AWARENESS LEVEL ACTIVITIES.....

Using Energy - Everyone, Everyday

I. Introduction

The purposes of this activity are for students:

a. to become aware that energy is an integral part of their lives.
b. to compare the ways in which members of the class use and value energy.
c. to evaluate their own energy uses and examine ways to conserve energy in their daily lives.
d. to learn to question each other and accept each others views.

This activity can be done by students in grades 5-10. Responses and depth of thought will vary from grade to grade.

This activity is designed for students at the awareness level. It develops the categorizing, comparing, and questioning skills.

II. Questions

1. To lead to the activity

   a. What kinds of energy are there?
   b. What kinds of things in your house use energy?
   c. Can you give an example of how you use energy in school?

2. To initiate the activity
   a. How many ways can you think of that you have used energy since you woke up today? (List them)

3. To continue the activity

   a. Did you think about what woke you up today?
   b. Did you think about your breakfast?
   c. What about your transportation to school?
   d. How does energy keep you comfortable at home and at school?

4. To expand the activity

   a. Discuss your lists with each other. Do all the members of the class use energy in the same way? Compare your lists.
   b. Are there more similarities among certain groups, like boys and girls, adults and children?

c. Have you heard about the energy crisis? What does this mean?
d. How would you change your daily routine to save energy?

e. Discuss your means of saving energy with each other. Will you all save energy in the same way? Ask each other to explain why you chose these ways to conserve energy.

5. To evaluate the activity

a. Were students receptive to the fact that energy is an integral part of all of their lives?
b. Did students realize that different people have different views on energy uses and energy conservation?
c. Were students aware of the energy crisis?
d. Did students question each other readily and listen to each other's responses?
e. How many examples of uses of energy were students able to list independently?
f. Did an understanding of the meaning of the term "energy" and an appreciation of the many forms it takes begin to emerge from the discussions?

III. Equipment: Paper and pencils.

IV. Procedures

1. Introduce the activity
2. Initiate the activity. Allow students to work on their own personal lists.
3. Continue the activity and expand the activity by encouraging students to compare lists and discuss differences and similarities. Encourage students to formulate questions for each other to aid the discussion. Stress the fact that these are personal opinions and there are no correct answers to these questions.

FINE ACTIVITY

I Feel Tired

I. Introduction

How often do we hear people say, "I am so tired" and "I have no energy today". They just feel like sitting down and taking life easy. They just can't do any work. Well, let's talk about these people.

II. Questions

1. a. What do you feel like when you have no energy?
   b. What is energy?
   c. Where does it come from?
   d. What is the source of energy?

2. Initiate the activity

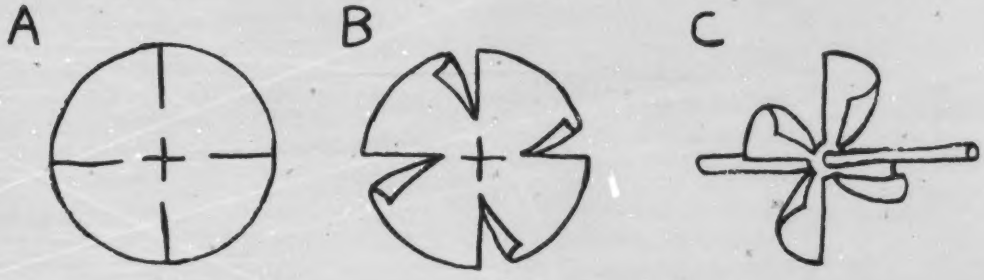
   a. Do you think all energy is the same?
   b. If I had a pinwheel and blew on it, what would happen?
   c. How does a ski lift get its passengers to the top of a ski jump?

3. Expand the activity

   a. How can we best use our energy?
   b. Is energy ever wasted? How?

4. Evaluate the activity

   a. Construct a pinwheel - cut a thin cardboard circle 3 inches in diameter.
      (1) draw lines as shown and cut slits in picture (A).



      (2) Bend the edges (B)
      (3) Push a pencil or straw through the center. Make the middle of the wheel wide enough so it spins easily.
   b. How does your pin wheel work?
   c. Are there any problems we did not consider thus far?

III. Equipment

a. Paper
b. Straws
c. Cardboard
d. Scissors

IV. Procedure

a. Ask who would like to find out what kind of energy is used in a ski lift.
b. Ask who would like to look up water wheel in an encyclopedia and write a report on the history of water wheels.
c. Who would like to write to a company and ask if we may come for a visit to see how they run their machinery.

THE CONCEPT OF THE VARIETY OF ENERGY SOURCES IS IMPORTANT. CAN YOU INVOLVE EVEN MORE IN YOUR DEVELOPMENT OF QUESTIONS?

Energy Cycle

I. Introduction

This activity is designed to introduce primary children to the energy cycle. Each child will be given an apple. Students will participate in the question and answer period according to their previous experiences. The discussion will take place outside where they can see the sun, trees and soil. It will last about 25 minutes. After the discussion, the children may eat the apples.

II. Questions

1. To lead to the activity, ask students:

   a. Where did the apple come from?
   b. What things were necessary to make it grow?
   c. What steps occurred from when the seed was planted until the tree produced an apple?

2. To initiate the activity

   a. What processes did the apple go through from the time it was picked until we got it?
   b. What people were involved in growing and marketing of the apple?
   c. What vehicles were involved in getting the apple to us?

3. To continue the activity

   a. What happens to the apple inside of us?
   b. Where do the wastes from our body go?
   c. What is the energy cycle?

4. To expand the activity ask:

   a. What are the many uses we have for apples?
   b. What other cycles in nature do you know about?

5. To evaluate the activity ask:

   a. What is energy?
   b. Where does all energy come from?
   c. Can energy be wasted?
   d. How can we use our energy best?

6. Equipment

   a. An apple
   b. Outdoor classroom
   c. Flannel Board and teacher prepared pictures and words to build energy cycle.
   d. Chart paper and magic marker.

IV. Procedure

   a. Have children eat apples and examine core for seed. Name parts of an apple - core, skin, seeds, pulp.
   b. Put up pictures of apple, tree, seed, people, vehicles, oil, refrigeration, storing, packaging, grocery store, sun, soil, water, as they are introduced into the cycle by the children's contributions.
   c. Chart knowledge learned in sentences. Draw attention to new vocabulary words. Stress beginning sounds of sun, soil, water, etc.

TECHNICALLY, ENERGY DOES NOT CYCLE IN A SYSTEM, BUT FLOWS THROUGH IT. WE ARE CONSTANTLY LOSING ENERGY (BY CONVERSION TO HEAT OR OTHER UNUSABLE FORMS, BY RADIATION TO SPACE) AND THEREFORE ARE IN NEED OF CONSTANT REPLENISHMENT. NUTRIENTS, ON THE OTHER HAND, DO CYCLE. THEY ARE NOT LOST FROM THE SYSTEM, BUT ARE CONSTANTLY TRANSFERRED FROM ONE FORM TO ANOTHER.

Studying Light Bulbs

I. Introduction

Sometimes consumers confuse brightness of light bulbs with wattage. This activity is designed to make junior high students aware of the differences in efficiency of light bulbs and the cost to the consumer.

II. Questions that lead to the activity:

a. What is a fluorescent light bulb?
b. What is an incandescent bulb?
c. What is wattage?
d. How many bulbs of each type do you have in your home and what are their wattages?
e. What other types of bulbs are there?

III. Questions that initiate the activity:

a. How does a 15 watt incandescent bulb compare to a 15 watt fluorscent bulb in brightness?
b. What other comparisons might there be? (Compare life, cost, etc.)

IV. Questions that continue the activity:

a. If the cost of electricity is approximately 5¢/kwh, how does the price compare if we allowed both bulbs to remain lit for the same amount of time?
b. Suppose you wanted to compare the savings if you changed from a 100 watt bulb to a 75 watt bulb. If both bulbs were to burn 4 hrs. per day, how many watt-hours a day would you save with the lower wattage?
c. How many watt-hours a year does this amount to?
d. How many kilowatt hours a year is this?
e. If the price of electricity is 5¢/kwh, how much of a saving is this?

V. Questions that expand the activity:

a. If there are 100 homes in your community and each replaced one 100 watt bulb with a 75 watt bulb, how many kilowatt hours would be saved?
b. What would this amount to in dollar savings?

VI. Questions that evaluate the activity:

a. What bulbs in your home could be changed for lower

watt bulbs and still provide sufficient light?

b. What can be done in the community's lighting system to save electricity?

c. What other ways can you think of to cut down on the use of kilowatt hours?

VII. Equipment

a. 1 15-watt fluorescent light bulb
b. 1 15-watt incandescent light bulb

VIII Procedure

The comparison of the two light bulbs are made by simple observation. The kilowatt hours are calculated by dividing 1000 into the number of watt-hours. Total cost is calculated by multiplying 5¢ times the number of kilowatt hours. Be sure to keep the cost current and applicable.

GOOD, CONCISE ACTIVITY. THE "QUESTIONS TO EXPAND" MIGHT SUGGEST MORE INVOLVED ACTIVITIES AT A TRANSITIONAL OR OPERATIONAL LEVEL.

Water and Energy Wastes From a Leaky Faucet

I. Introduction

Power plants change energy from many sources into electrical energy. Electricity from a large number of generating stations burn fossil fuels. However, our supply of fossil fuels is being depleted and is becoming very costly. We must learn to conserve electricity while we seek and build new alternatives. This activity is an awareness activity designed to demonstrate one way to conserve water and energy. It can be used at both the upper elementary and secondary levels with some modifications.

II. Questions

1. Questions which lead to the activity:

   a. What energy sources are used to produce electricity?
   b. In what ways do you use electricity at home? at school?

2. Questions to initiate the activity:

   a. Is there an unlimited amount of fuel available to produce electricity?
   b. Are we able to meet all our demands for electricity?
   c. What can you do to conserve energy at home? at school?

3. Questions to continue activity:

   a. How can a leaky faucet waste energy?
   b. How much water is wasted from one leaky faucet - 1 hour, 1 day, 1 month, 1 year?
   c. How many times does the water pump run due to a leaky faucet - 1 hour, 1 day, 1 month, 1 year?
   d. How much power is used each time the water pump starts?
   e. How much does a leaky faucet cost in power - 1 hour, 1 day, 1 month, 1 year?

4. Questions to evaluate the activity:

   a. Were students able to realize their tremendous uses of electricity?
   b. Do students realize we have an energy crisis?
   c. Were students able to suggest ways to conserve energy?
   d. Are students willing to put some of these remedies into practice?

III. Equipment

1. Leaky faucet or one adjusted to drip slowly.
2. Large container to collect water.
3. Measuring cup
4. Paper
5. Pencil

IV. Procedure

1. Place large container under leaky faucet.
2. Collect water for 1 hour.
3. Measure collected water and record results.
4. Repeat above 2 more times and get average (optional)
5. Figure out how much water is wasted in 1 day, 1 month, 1 year.
6. While collecting water, record how many times pump runs.
7. Find out how much power your pump uses.
8. Find out cost of electricity in your area.
9. Figure out how much energy is used by 1 leaky faucet in 1 day, 1 month, 1 year.
10. Figure out the cost of this power for 1 day, 1 month, and 1 year.

YOU MAY REQUIRE SOME MODIFICATIONS FOR STUDENTS WITH A PUBLIC WATER SUPPLY. IS IT A LEAKY HOT WATER FAUCET OR COLD?

Serigraphy

I. Evaluation of Art Room from energy use standpoint.

II. Each student should choose an object within the art room which uses electrical energy re: sewing machine, light bulbs., and redo that object in colored pencil.

III. Transfer drawing to silkscreen.

IV. Final print will be glued to piece of cardboard, cut up, and reassembled in puzzle form.

COULD THE STUDENTS RENDITION OF THE OBJECT REFLECT ITS RELATIVE ENERGY EFFICIENCY OR ITS SOURCE OF POWER?

COULD ALL OF THE FINAL PRINTS BE MOUNTED AS A COLLAGE REPRESENTING TOTAL ART ROOM ENERGY USAGE?

THE QUESTION FORMAT SHOULD BE EMPLOYED HERE TO HELP STIMULATE THE STUDENTS' OWN THOUGHT AND CREATIVE POWERS.

Kilo-What?

I. Introduction

This activity is an awareness level activity for 5th and 6th grade students utilizing observation, comparison, and measurement techniques. The purpose is to assist the students in understanding how electric energy use is monitored and electric bills determined.

II. Questions

1. To lead to the activity:

   a. Do your parents complain about too many lights, appliances, etc. being used or left on at home?
   b. Does Mom or Dad complain about electric bills?

2. To initiate the activity:

   a. How does PECO monitor electric consumption?
   b. How do you read an electric meter?

3. To continue the activity:

   a. What are kilowatt hours?
   b. How do you read an electric bill?
   c. What is the cost per kilowatt hour?

4. To expand the activity:

   a. When do you use the greatest amount of electricity?
      (1) day/night?
      (2) seasons of the year?
   b. How can you determine this?
   c. How can you conserve electricity at home?
   d. How does your use compare with others?

5. To evaluate the activity:

   a. Did students understand "monitoring"?
   b. Do students know how to read meters?
   c. Do students know how electric bills are determined and how to check them?

III. Equipment: None except home electric meter.

IV. Procedures

1. Initiate discussion.
2. Review monitoring procedures (how this differs from sampling)
3. Instruct in meter reading.
4. Instruct in PECO bill reading.

WILL EACH STUDENT BE RESPONSIBLE FOR READING HIS OWN HOME METER AND BILL?

Consumption-Pollution?

I. Introduction

This activity is for first year biology students to help them realize the importance of the role of the consumer with regard to the problem of thermal pollution. It is an awareness activity. (1 class period)

II. Questions

1. To lead to the activity:

   a. What is thermal pollution?
   b. What are the main sources of thermal pollution?

2. To initiate the activity:

   a. What are the effects of thermal pollution on aquatic life?
   b. What are the ultimate effects on the world ecosystem (biosphere)?

3. To continue the activity:

   a. What are some methods of minimizing thermal pollution?
   b. What are the non-essential electrical devices found in your home?

4. To expand the activity:

   a. Would cut-back in use of electricity be a reasonable alternative to the building of more power plants?
   b. Could neon signs, electric brooms, electric can-openers, air conditioners, and such be banned?
   c. Do affluent people have the right to use such devices when all people, ultimately, will be affected?
   d. Could U.S. economy sustain itself if non-essential electrical devices were banned?

5. To evaluate the activity:

   a. Did students realize the important role the consumer ultimately plays in thermal pollution?
   b. Did students understand the concept that one result of more people and a higher standard of living is to increase the need for more energy (electricity) and therefore, increase thermal pollution?

III. Equipment - None

IV. Procedures

1. Initiate discussion with questions.

THE TRANSITION FROM THERMAL POLLUTION TO NON-ESSENTIAL APPLIANCES SEEMS A BIT ABRUPT. TRY ADDING SOME QUESTIONS.

Home Use

I. Introduction

This activity is for students to become more aware of the importance of electricity and energy in their lives. Grade level-6th. Awareness activity-using observing, categorizing & comparing.

II. Questions

1. To lead to the activity:

   a. Is electricity important to people? Why?

2. To initiate the activity:

   a. How important is electricity in your own life?
   b. How many things do you have or use at home that are electrical?

3. To continue the activity:

   a. How many of these things are really necessary for you to live?
   b. How many are for your enjoyment or recreation?
   c. Could you do without any to conserve electricity?

4. To expand the activity:

   a. Is electricity important to you in school? How?
   b. How many things in our school use electricity?
   c. Are they all necessary for running the school? Why or why not?
   d. Could we as a school cut down on our use of electricity? How?

5. To evaluate the activity:

   a. Did the students find that there are more things in their lives that use electricity than they thought?
   b. Did the students come up with items to eliminate at home and at school to help conserve electricity?

III. Equipment

1. Pencil
2. Paper

IV. Procedures

1. Discuss leading and initiating questions.
2. Make lists of electrical appliances at home. Mark those that are necessary to live and those for enjoyment.
3. Divide into small groups and go through school making lists of all electrical appliances.
4. Finish discussing questions.

THE "TO EXPAND THE ACTIVITY" SECTION SHOULD BE USED TO SUGGEST NEW DIRECTIONS OR POSSIBLE ADDITIONAL ACTIVITIES, THINGS NOT COVERED BY THE ACTIVITY AT HAND. SUCH AS: AN ENERGY SAVING CAMPAIGN, ARTICLES IN THE SCHOOL NEWSPAPER, POSTERS FOR COMMUNITY DISPLAY, ETC.

Everybody Uses It

I. Introduction

Activity is designed to acquaint students with forms of energy and what effects it has on them and their parents as users of this energy; grades 2-4; awareness activity.

II. Questions

1. To lead to the activity:

   a. If you want to read a book or do your homework in your bedroom and it's dark in there, what do you do?
   b. If you buy a popscicle and want to save it for later, where would you put it? Why?

2. To initiate the activity:

   a. What makes the lights come on and the refrigerator run?

3. To continue the activity:

   a. Where does electricity come from?
   b. Do you see any wires attached to your house? What are they for?

4. To expand the activity:

   a. Is electricity free or do we pay for it?
   b. Who and/or what brings it to your house?
   c. If we have five lights on instead of two. Is more energy consumed? Does five cost more?
   d. Should we be careful about how much energy we use? Why?
   e. Is it possible to use up all our energy - Did you ever use up your energy when you ran for a long time? GOOD PARALLEL
   f. Does this give you any ideas about how to save electricity or energy - would that save you money?

5. To evaluate the activity:

   a. Do students understand basic idea of what energy is?
   b. Do they realize that some changes must come about in relation to consumption?

III. Equipment - None

IV. Procedure

a. Compare each other's electric bills.
b. Discussion.

A FURTHER DEVELOPMENT OF FORMS OF ENERGY, OTHER THAN ELECTRICITY, MIGHT BE GOOD.

Whose Crisis?

I. Introduction

Designed for students living in a lower socio-economic environment; to aid them in understanding what an energy crisis is. Levels 2-4.

II. Questions

1. To lead to the activity:

   a. What is energy?
   b. What is a crisis?
   c. If we put the two definitions together what do we wind up with? (Energy Crisis)

2. To initiate the activity:

   a. Can we do without energy?
   b. What situations did we have last winter when there was a shortage of oil and gasoline?
   c. Why are we asked to keep the thermostat at 68°F in the winter?
   d. Why were we on daylight saving time most of the year?

3. To continue the activity:

   a. What can you as a person do to save energy?
   b. What can you ask your parents to do to save energy?
   c. What can we as a class do to save energy?

4. To expand the activity:

   a. Do you think there's any way we can store or keep energy for future use?
   b. Let's list some ways we can run a save energy campaign in our school and community.

5. To evaluate the activity:

   a. See if our Save Energy Campaign was a success.

III. Equipment - No special equipment needed.

IV. PROCEDURE?

WHAT ABOUT QUESTIONS DEALING WITH DIFFERENT TYPES AND SOURCES OF ENERGY?

Rising Appliances

I. Introduction

This activity is designed for the awareness level (5th level) student to develop the processes of categorizing and comparing. It is hoped the student will realize the dramatic increase in the number of electric appliances in the recent past.

II. Questions

1. How many electrical appliances did you use this morning before leaving for school?
2. How many appliances can you name in your house that require energy of some kind?
3. Ask your parents to list the appliances they had in their house when they were your age?
4. If possible, obtain a list from your grandparents of the appliances they had in their house as a child.
5. How do the three lists compare?
6. Who had the most?
7. What does this mean in terms of energy required now and in the past?
8. What is required to produce electricity? How is it produced?
9. Can you think of any environmental problems as a result of the increased power required by society?

III. Equipment - None

IV. Procedures

1. Turn off the lights in the room. What is needed for the lights to work?
2. Commence questions to generate discussion.

GOOD DIRECTION, BUT QUESTIONS SHOULD HAVE BEEN ORGANIZED AS QUESTIONS TO: LEAD TO, INITIATE, CONTINUE, EXPAND, AND EVALUATE THE ACTIVITY.

Black-Out!

I. Introduction

This is an activity for students who are unaware of the extent of their dependency upon a source of energy. This is for grade levels 5-9. It is an awareness activity simulating a 24 hour black out of electrical power.

II. Questions

1. To lead to the activity:

   a. For what do people use electricity?
   b. Which electrically powered things can be powered by humans?

2. To initiate activity:

   a. Why was there no energy crisis in the early 1900's?
   b. In order to solve the energy crisis, why do we not just ration out the available energy?

3. To continue the activity:

   a. How much do you depend upon electricity?
   b. How many kilowatts of electricity does your family use on an average each month?

4. To expand the activity:

   a. Simulate a 24 hour blackout

      (1) Did you do anything differently than you normally do upon returning home from school?
      (2) Was your dinner different?
      (3) Did you do your homework at a different time?
      (4) How many times did you open the refrigerator?
      (5) Did the temperature of your house change?
      (6) What did you have to use your own power to do that is normally powered by electricity?
      (7) Did you change your early evening activities?
      (8) Did you go to bed earlier?
      (9) If the other members of your family participated in the "blackout", how did it change their day?
      (10) How many times did you forget and turn on the power?
      (11) How many of the objects that were "out of use" today would you do without for a week? for a month? for a year?

5. To evaluate the activity:

   a. Did students carry out simulation?
   b. Did students realize which electrical appliances were necessities, which were conveniences, and which were useless conveniences to them?
   c. Did the students understand the kilowatt as a unit of electricity?

III. Equipment

1. Old electric bill from individual families.

IV. Procedures

1. Ask questions (parts 1 & 2)
2. Ask the students to simulate a "blackout" for 24 hours by not using any electric appliances and by pretending all electricity is off for one day.
3. Initiate questions in order to continue the activity (part 3)

SOUNDS LIKE YOUR QUESTIONS TO CONTINUE AND TO EXPAND SHOULD BE REVERSED.

A NICE SIMULATION IN THAT IT IS NOT AS ABSTRACT AS MOST GAMES.

Dependence Grows

I. Introduction

The purpose of this activity is to illustrate the relatively short period of time that man has been dependent on electricity. The students determine when individual electrical inventions were made, and how each influenced their lives. This activity is for students beginning an energy unit.

II. Procedure

1. A model of a clock face with 60 minutes is presented to the class. The clock face will be used to represent the last 100 years. The students name electrical appliances OR devices, and then research (immediately) their introduction to the public. The appearance of each device is marked on our model.

   Questions follow the completion of model.

III. Questions (The questions are presented to the class for discussion)

1. When did we become dependent on electricity?
2. What does our clock indicate about the rate of technical change?
3. Why does man use electrical energy?
4. Which electrical devices are most important to you?
5. Why?
6. Which electrical devices are most important to mankind?
7. Why?
8. How would you be affected, if there were no electricity available?

IV. Equipment:

1. Blank, 60-minute clock face.
2. Markers for use on the clock.

THE POINT OF THE QUESTIONING FORMAT IS TO DEVELOP AND MAINTAIN STUDENT INTEREST. QUESTIONS SHOULD THEREFORE BE DEVELOPED FOR USE BEFORE, DURING, AND AFTER AN ACTIVITY.

Dealing With Packaging

I. Introduction

This activity is to make the student aware of the waste and energy that goes into the packaging of materials. Grades 10-12.

II. Questions

1. To lead to the activity:

   a. What types of waste does every person produce?
   b. How is waste dealt with?

2. To initiate the activity:

   a. What different types of energy go into making of packaging materials?
   b. What types of packaging are there?

3. To continue the activity:

   a. Which types of packaging use the least energy to produce, dispose of?
   b. How can we save some of the energy?

4. To expand the activity:

   a. How much packaging material does one person use in one day? one week? one year?

5. To evaluate the activity:

   a. How extensive was the list of types of energy?
   b. How extensive was the list of types of packaging materials?
   c. Did the students come up with a few ways to save energy?

III. Equipment

1. Paper
2. Pencil or pen

iv. Procedure

1. Split up the class into teams of two or three. After the teams complete the list, make one complete list on the board. Then have each student keep a record of all packaging material used in one day.

WHAT ABOUT SURVEYS OF "REAL" AREAS, NOT JUST THOUGHT SURVEYS IN CLASS. GROCERY, HARDWARE, DEPARTMENT STORES, COULD BE ANALYZED. CHECK THE TRASH AT HOME, AT SCHOOL, AT THE SHOPPING CENTER

Energy Costs

I. Introduction

To make the student aware of why we have high costs in the generation of electrical energy.

II. Questions

1. a. Why do you think electrical energy is expensive?
   b. Is it expensive or not?

2. a. How is it generated?
   b. How is it transferred?

3. a. Where is your home electricity generated?
   b. How does it get to you?

4. a. Do you think these things add to the cost of electricity? How?
   b. What else adds to the cost?

5. a. How do you feel about electric rates now?
   b. Should we pay more if it will make our environment better?

III. EQUIPMENT?

IV. PROCEDURE?

FORMAT NEEDS ATTENTION. QUESTIONS INSUFFICIENTLY DEVELOPED.

$$$$$$$$

I. Introduction

This activity is for students looking for ideas to help ease the energy crunch. It is an awareness activity for children, free spirits of the earth.

II. Questions

1. To lead to the activity:

   a. What does energy mean?
   b. Do we need energy to live?
   c. What kinds of energy can you list?

2. To initiate the activity:

   a. What might happen if we all run out of energy?
   b. Can you think of ways to save energy?

3. To continue the activity:

   a. How could you replace energy with manpower?
   b. How can we get others to save energy?

4. To evaluate the activity:

   a. Did the students brain storm for clever and better air pollution solutions?
   b. Were the students surprised to see how easy it is to save "everyday" energy?

III. Equipment

1. Blackboard and chalk.

IV. Procedure

1. Stage a blackout to stimulate awareness of the implications of the energy crisis.

IS NOT "MAN-POWER" JUST ANOTHER FORM OF ENERGY? COULD A CAMPAIGN TO SAVE ENERGY AT HOME AND IN SCHOOL BE AN EXPANSION OF THE ACTIVITY?

Conservatism In Consumerism

I. Introduction

This program is designed to familiarize the student with conservation methods on which the consumer may focus within the home, in regard to major electrical appliances, and their usage and cost.

II. Defining Terms:

1. What is Conservation?
2. Who or What is a Consumer?
3. What are major electrical appliances?

III. Lead in to activity:

1. What major electrical appliances control your family's homelife?
2. What minor electrical appliances play an important part in your family's life?

IV. To initiate activity:

Dividing into groups of approximately five.

1. In your groups what are the five most commonly used major appliances?
2. In your groups, what are the ten most commonly used minor appliances?
3. What is the approximate usage time per week in minutes of both the agreed upon major and minor appliances?

V. To continue the activity:

1. Using the charts given you on estimated power consumption of the major electrical appliances, estimate the KWH consumed annually by that product.
2. Using the charts given you on estimated power consumption of minor electrical appliances, estimate the KWH consumed annually by that product.
3. When we speak of kilowatt hours, (KWH) what are we referring to?
4. Determine the cost of electricity used to run each major appliance throughout the year. (Use the cost of four cents (4¢) per KWH).
5. Determine the cost of electricity used to run each minor appliance for one year.

VI. To expand activity:

1. Knowing cost per year, what major appliances are necessary for you to maintain your standard of living? What can be cut back in usage?
2. Knowing cost per year, what minor appliances are necessary? What can you cut back on? What can you do without?
3. What standard of living do you wish to maintain? Present level? A slight cut back? A drastic reduction in your standard of living?

VII. To evaluate the activity:

1. Do the students understand the terms involved in activity? (Ex. Consumer, Conservation, KWH, Standard of living).
2. Are students more aware of conservation of electricity?
3. Are students more aware of consumer choices?
4. Are students aware of cost per appliances used in the home?

VIII. Equipment

1. Charts showing a relationship between major and minor appliances and their consumption of KWH, thus cost per year of usage.

IX. Procedures

1. Defining of difficult terms used in activity.
2. Allowing students to determine what major and minor appliances they use the most.
3. Supplying charts of appliance consumption of KWH and cost per KWH.
4. Let the students complete as much of the activity on their own as possible.

ONCE THE STUDENTS DETERMINE WHAT CUT-BACKS ARE POSSIBLE, WHY NOT TRY THE CUT-BACKS. IF THE ACTIVITY IS STARTED AT THE BEGINNING OF THE YEAR, ACTUAL SAVINGS MIGHT BE NOTICED BY THE END OF THE SCHOOL SESSION. THE EFFECTS OF SEVERAL "STANDARDS OF LIVING" ON THE TOTAL ENVIRONMENT SHOULD BE INVESTIGATED.

Energy And The Apple

I. Introduction

This is an awareness exercise for tenth grade biology students.

II. Procedures

1. Students will be divided into groups.
2. The groups will be given a particular type of food.
3. The groups are to determine what types of energy are used to produce and transport this substance.
4. They are to determine what energy, if any, they would derive from the substance.
5. Determine how this substance obtained its energy.

III. Evaluation

1. Were the students aware of the types of energy involved in producing the food substance?
2. Were the students aware of how they receive the energy from this food substance?

YOUR FORMAT NEEDS ATTENTION. ONE REASON FOR USING THE QUESTIONING APPROACH, IS TO GET THE STUDENTS THEMSELVES TO DEVELOP AS MUCH OF THE ANALYSIS PROCEDURE AS POSSIBLE. WE'RE INTERESTED IN THE PROCESS OF LEARNING FIRST, THE CONTENT WILL FOLLOW INTEREST.

Sources of Energy in the Classroom

I. Introduction

This is an awareness activity for junior high. It will use the process skills of observing, categorizing, and comparing in order to develop awareness of the different sources of our energy.

II. Questions

1. To lead to the activity:

   a. Why do we need to use energy?
   b. What different sources of energy can you think of?

2. To initiate the activity:

   a. What kinds of energy do we use in our classroom?
   b. Why do we need energy in our classroom?
   c. What are the sources of the energy in our classroom?

3. To continue and expand the activity:

   a. How does energy use and source in your home compare with that in the classroom?
   b. How do the uses and sources of energy now compare to 100 years ago?
   c. How do you think energy uses and sources will change in the next 100 years?

4. To evaluate the activity:

   a. Did the students perceive that our energy comes from several different sources, but primarily from fossil fuel?
   b. Were the students aware that there has been a great increase in our use of energy?
   c. Were the students aware that there has been a change in our sources of energy?
   d. Did the students suggest a study of energy use in their homes?

III. Equipment

1. Paper, pencils, chalkboard, chalk.

IV. Procedure

1. Divide the class into groups of 3-6 students.
2. Have each group categorize by sources all our energy use in the classroom.
3. Compare lists and put composite list on chalkboard.
4. Continue discussion.

EXPANSION QUESTIONS SHOULD BE EMPLOYED TO LEAD THE STUDENTS TO FURTHER ACTIVITIES.

The Electric Meter and Your Pocketbook

I. Introduction

The activity is designed to aquaint the student with the procedures involved in determining how much electric power is used by different appliances.

II. Questions

1. Leading

   a. Why is electricity so important to our society today?
   b. Why is it becoming more important?

2. Initiating

   a. How much electricity does your family use each month?
   b. What electric appliances does your family use most often?

3. Continuing

   a. How long is each appliance used each day?
   b. How much power does each one use each day?

4. Expanding

   a. Do you know where to find out how much electricity each one used?
   b. Do you know how much it costs to run these appliances each day?
   c. How many dollars of electricity do you use every day with the appliance you use?
   d. How can you help to save electricity with the appliance you use everyday?
   e. For the other appliances your family uses, are there any other ways of doing the same job without using as much electricity?

5. Evaluation

   a. Were the students able to calculate their family's daily and monthly electric usage and its cost?
   b. Were the students able to find ways of reducing their personal electrical energy usage?

c. Were the students able to find alternative ways of doing the jobs that appliances are now doing in their homes?
d. How compatable are these alternatives with the environment?

III. Equipment

1. Paper and pencil
2. Watch
3. Formula for calculating electric power.

IV. Procedure

1. Make a list of electric appliances in the home.
2. Determine the length of time each is used a day by the individuals at home.
3. Determine the cost of the electricity each uses a day.
4. Determine the cost of running the appliances the student uses each day.
5. Extrapolate this information into a monthly electric bill.
6. How close was this usage estimate and the cost estimate to the actual use and cost?

AN EXPANSION MIGHT BE TO INSTITUTE A CONSERVATION PLAN AND COMPARE SUBSEQUENT MONTHLY BILLS.

TRANSITIONAL LEVEL ACTIVITIES.....

47

Why Are Those Electric Bills So High?

I. Introduction

This activity is designed to give students an opportunity to increase their powers of observation and to have practice in recording data. It is a transitional activity and will use data collection and processing techniques. It will also give eleventh grade chemistry students additional practice in the factor-label method of unit conversion.

II. Questions

1. To lead:

   a. How much electric energy does your family directly consume each day?
   b. How much does this energy cost your family each day?
   c. Are there hidden users of electricity in your home?

2. To initiate:

   a. What are the appliances that are used in your home which consume electricity?

3. To continue:

   a. What amount of time are these appliances in use during a 24 hour period in your home?

4. To expand:

   a. Is there a difference between the types of appliances and the amount of time they are used between a 24 hour period Monday through Friday and a 24 hour period Saturday and Sunday?

5. To evaluate:

   a. What is the total amount of electrical energy consumed in a 24 hour period during Monday through Friday?
   b. What is the difference between the amount of electricity calculated in question 5-a. and the meter reading for the same 24 hours?
   c. What is the cost of these amounts of electricity?
   d. How much electricity cannot be accounted for?

III. Equipment

1. Table of estimated power consumption of electrical appliances.
2. Current rate of cost of a kilowatt hour of electricity.

IV. Procedure

1. Discuss, lead and initiate questions in class, allowing time to list appliances.
2. Students should prepare diary of electrical appliance use for a 24 hour period.
3. Discuss, continue and expand questions.
4. Students should complete evaluation questions and prepare a report of their family's electricity consumption for a 24 hour period.

WHAT ARE THE ENERGY USE DIFFERENCES AMONG THE STUDENTS?

WHAT CAN BE DONE ABOUT THOSE DIFFERENCES?

Include our example of a factor-label method problem.

Is a hypothesis formulated here?

Generating Electricity

I. Introduction

This activity is a transitional activity for the senior high school level. It is for students to learn ways that electricity is generated, some of the problems of generating electricity, and the tremendous importance electricity has in our present society.

II. Questions

1. To lead to the activity:

   a. How do we use electricity in our everyday life?
   b. How is our pattern of living changed by the loss of electricity, such as in an electric storm?
   c. What is electricity?

2. To initiate the activity:

   a. What are some sources of energy that can be used to produce electricity?
   b. Do you know of any electric generating plants in the nearby area?
   c. If so, where is the plant located?

3. To continue the activity:

   a. What are some of the common methods of generating electricity?
   b. Basically, how does each method of generation work?

4. To expand the activity:

   a. What type of location is chosen for most electric generating stations.
   b. Can you name nearby generating stations that use each of the methods of generating?
   c. How is the electricity transported from the power plant to the consumer?
   d. Can electricity be produced and stored until needed?
   e. How much does electricity cost?

f. Does this seem like a lot?
g. Can you determine any reasons for electricity costing this amount?

5. To evaluate the activity:

a. Did the students perceive the different ways of generating electricity?
b. Were the students aware of the extreme importance of electricity in their lives?
c. Did the students perceive any problems of generating electricity during the discussion?

III. Equipment

1. Library
2. List of addresses of energy-related businesses and groups.

IV. Procedures

1. Initiate questions to generate a discussion to lead into the activity.
2. Allow research time between question areas, then continue in discussion.

COULD THE RESEARCH BE DONE IN THE "REAL" WORLD RATHER THAN SOLELY IN THE LIBRARY? WHAT ABOUT TRIPS TO GENERATING PLANTS, INTERVIEWS WITH PLANT STAFF, ETC.? BY "DIFFERENT WAYS OF GENERATING ELECTRICITY", YOU REALLY MEAN DIFFERENT ENERGY SOURCES, DON'T YOU? HYPOTHESES?

It All Adds Up

I. Introduction

This exercise is developed to give students an idea of how much electricity they use and how they can conserve electricity.

II. Questions

1. How much money do you think that your family pays for electricity in one year?
2. List all of the appliances or machines that use electricity in your house?
3. Next to each appliance listed estimate how many kilowatt hours the appliance uses per year. Use the table provided to find this "information".
4. Using 4¢ per kilowatt hour, calculate your estimate of yearly electricity bill.
5. Choose appliances that you feel are not necessary and take the yearly expenditure for each of those appliances and add them together. What is your yearly savings?
6. What are some other methods of conserving electricity and lowering your bill other than not using those appliances that you feel are not necessary.

III. Equipment

1. Tables listing estimated power consumption of electric appliances.

IV. Procedure

1. Start questions.

MIGHT ALSO: COMPARE THE ESTIMATED BILL WITH THE ACTUAL BILL:
APPLY THE SAME PROCEDURE TO YOUR SCHOOL:
ORGANIZE A CONSERVATION CAMPAIGN AS AN EXPANSION.

QUESTIONS SHOULD BE ORGANIZED AS LEAD TO, INITIATE, ETC.

House Current

I. Introduction

This activity is for 11th and 12th grade Physics or Applied Science students. It is a transitional level activity using data collection, data processing, data evaluation and formulation of hypotheses.

II. Questions

1. To lead to the activity:

   a. What are the three appliances in your house that use the most electricity?
   b. What are the three appliances in your house that use the least electricity?

2. To initiate the activity:

   a. What are the two appliances in your house that you "could best do without"?
   b. What are the two appliances in your house that you feel are most important to you personally?

3. To continue the activity:

   a. Were your estimates of the appliances that use the most and least the same as those listed?
   b. Can you use the list and estimate the time used and find the cost per year of items from question 1?
   c. If you had to decide to have your electricity bill double in order to pay for pollution reduction or to keep the same rate and same pollution, which would you choose?

4. To expand the activity:

   a. Were the items you selected as "could best do without" the same as other peoples?
   b. Do you think other members of your family would agree with your could best do without list? Why not ask them?
   c. Were the items on your "personally most important list" the same? (As What)
   d. Do others in your class agree with your pollution solution?
   e. Do you think people in an area polluted by electrical generation would agree with your "pollution solution"?

5. To evaluate the activity:

   a. Did students know the electrical consumption rate of appliances?
   b. Could students calculate the cost?
   c. Were students willing to pay for pollution reduction?
   d. Did the students perceive their view was biased and everyone else's view would be too?

III. Equipment

1. Pencil and paper
2. Reference table of appliances, wattages and electrical rates
3. Hand calculator.

IV. Procedures

1. Have student make up "most", "least", "better" and "personal" lists.
2. Have students check reference and revise their lists.
3. Have them estimate times used and calculate costs.
4. Have them decide the kind of service they would like.
5. Have students compare "better off" and "personal" lists and their pollution solutions.

IS THERE AN "ACTION" COURSE POSSIBLE AS AN EXPANSION OF THIS ACTIVITY?

OPERATIONAL LEVEL ACTIVITY.....

Another Rate Increase?

I. Introduction

The purpose of this activity is to initiate activity on the part of students as electric consumers. Hypothetically, they were told by their parents that since they left the light on in their room, they are responsible for a portion of the family's next electric bills. They are told to examine the family electric bills for the past two years. They are told what each figure means on the bill.

II. Activity

1. Record in two columns for each month and for the two consecutive years the family use of electricity and cost.

   a. Has your total family use increased or decreased for each year?
   b. What season was use highest, lowest?
   c. Has the total cost increased or decreased?
   d. What month has the largest fuel adjustment increase, the least increase?

III. Processing

1. Write to your electric utility company and request a rate schedule. In your letter, request clarification of the cost increase. Explain that your family has reduced its consumption of electricity, but the cost has still gone up.

2. Have students share their findings and the responses they received from the utility company.

QUESTIONING SECTION NEEDS MORE DEVELOPMENT TO FOLLOW WHAT YOU SEEM TO BE DOING IN YOUR "PROCESSING" SECTION. QUESTIONS (WHICH HELP THE STUDENT PERCEIVE THE NEED TO KNOW), RATHER THAN INSTRUCTIONS, ARE OF PARAMOUNT IMPORTANCE. OPERATIONAL ACTIVITIES DO NOT DEAL WITH HYPOTHETICAL SITUATIONS! PROBLEM RECOGNITION AND DEFINITION (ON THE PART OF THE STUDENTS), PROBLEM ANALYSIS AND DATA UTILIZATION ARE MISSING OR VERY WEAK. HYPOTHESIS?

ENERGY AND WATER POLLUTION

Page No.

AWARENESS LEVEL ACTIVITIES:

Hot Spots..... 50
How Can You Tell?..... 52
Aeration and Aquatic Life..... 54
Who Needs Water?..... 56
Then And Now..... 58
What Are Ways To Measure Pollution?..... 59
Dirty Words..... 61
Water's Role..... 63
A Fishy Question..... 65
The Chlorinated River..... 67
Water For Survival..... 68
A Problem Of Values..... 70
Drink The Water?..... 72
What Do You Do With The Wastes?..... 73
Energy Aliases..... 75
Generators Aren't The Only Thermal Polluters..... 77
What's The Water Like?..... 79

TRANSITIONAL LEVEL ACTIVITIES:

Effects Of Heat On Goldfish..... 81
Thermal Pollutions - Effects On Bacterial And Fungal Population..... 83
Water Pollution Vs. Dissolved Oxygen..... 86
Effect Of Thermal Pollution On Dissolved Oxygen..... 88
Breathing Hot Water..... 90
Brine Shrimp-A Feathery Barometer..... 92
Thermal Effects..... 94
Electricity And Water Pollution..... 95

AWARENESS LEVEL ACTIVITIES....

Hot Spots

I. Introduction

This activity is an awareness activity for 5-6th level students utilizing observation, comparison, measurement, and reference skills. The purpose is to aquaint the student with the effects of sunlight on the temperature of air and water.

II. Questions

1. To lead to the activity:

   a. Does solar energy contribute to the temperature of the air?
   b. Does solar energy contribute to the temperature of the water?

2. To initiate the activity:

   a. How can we determine the temperature of the air and water?
   b. How should we sample this temperature?

3. To continue the activity:

   a. How many sites should be sampled?
   b. What should be the location of the sites?
   c. Why is location important?

4. To expand the activity:

   a. Can we determine 24 hour variation?
   b. Can we determine seasonal variation?
   c. What other factors might influence the temperature of the air/water?

5. Evaluation:

   a. Did students gain an understanding of sampling?
   b. Did students gain an understanding of site location selection?
   c. Did students gain an understanding of daily/seasonal temperatures.

III. Equipment: Thermometers

IV. Procedure:

1. Initiate questions.
2. Divide into teams of students (determine by number of thermometers)
3. Review the use of thermometers and temperature scales.
4. Determine sites for sampling-select using map of school grounds or location desired. Number and mark each location, assign groups to specific sites.
5. Determine sampling techniques to receive uniform results.

    a. Air temperature at uniform level-ie: one meter, two meters above ground.
    b. Water temperature at uniform depth-ie: 4 cm., 8 cm., etc.

Our school property does have open space areas, wooded areas, and a small stream which crosses both types of areas. This provides variety of sampling sites.

It might be of benefit to compile this type activity with one on a heat and temperature comparison. Could demonstrate or set up student activity to illustrate the differences between heat and temperature by adding equal heat energy to two unequal volumes of water and determining the amount of time it takes to reach equal thermometer temperature. Discussion could lead to BTU and calorie units.

GOOD APPROACH.

YOUR FINAL HEAT/TEMPERATURE SUGGESTIONS COULD BE HINTED AT IN THE "QUESTIONS TO EXPAND" SECTION.

How Can You Tell?

I. Introduction

This activity is for students to become more aware of how an electricity-generating plant might have something to do with changes in a stream. Grade level-6th. Awareness activity using observing, inferring, and comparing.

II. Questions

1. To lead to the activity:

   a. What is water pollution?
   b. Can we see it?
   c. What can cause it?

2. To initiate the activity:

   a. Could an electricity-generating plant contribute to water pollution? Why or why not?
   b. How could we tell? What things could we do or look for?

3. To continue the activity:

   a. What did you find?
   b. Do your findings tell you that the water is polluted?

4. To expand the activity:

   a. Were your findings necessarily due to the plant or could they have come from somewhere else?
   b. How could we find out?

5. To evaluate the activity:

   a. What kinds of things did the students suggest to look for in order to decide whether the stream is polluted or not?
   b. Did they realize that they would have to look at more than one place in the stream to determine if the power plant was causing any change in it?
   c. Do they seem to have a fair understanding of water pollution and one of the possible causes of it?

III. Equipment

1. Stream at Hatfield Electric plant
2. Paper and pencil
3. Jars, nets, etc. (depends on students' suggestions)
4. Clothes for wading in the water.

IV. Procedure (1 or 2 class periods)

1. Discuss leading and initiating questions.
2. Write down and discuss students' suggestions for checking for polluted water. Try some of these suggestions.
3. Discuss continuing and expanding questions.
4. Check other spots upstream and downstream to see if there is any changes visible in the stream.
5. Come to a conclusion as to whether (by sight or simple study of the stream) we can tell that the stream is being polluted by the electricity-generating plant.

GOOD STUDENT INVOLVEMENT.

GOOD APPROACH TO THE CONCEPT OF CHANGE.

Aeration and Aquatic Life

I. Introduction

This activity is for students who are beginning a course in biology. It is an awareness and transitional activity to supply background information to do a laboratory study of local stream water to determine interrelationships between producers and consumers.

II. Questions

1. To lead to the activity:

   a. What is the original source of all energy?
   b. What are producers?
   c. What are consumers?
   d. What is a food chain?
   e. What is a food web?
   f. What is an ecosystem?
   g. How does energy pass through an ecosystem?
   h. How does an energy pyramid function?

2. To initiate the activity:

   a. How would an aquatic ecosystem respond to the sudden death of a high percentage of its producers?

3. To continue the activity:

   a. What kinds of pollutants might affect an aquatic ecosystem?
   b. What kinds of producers might be found in a local stream?
   c. What kinds of consumers might be found in a local stream?

4. To expand the activity:

   a. By what processes do pollutants adversely affect an aquatic ecosystem?
   b. What kinds of tests might be feasible to perform to discover the effect of pollutants in a stream?

5. To evaluate the activity:

   a. Did students understand: energy, food chain, food web, ecosystem, producers, consumers, pollutants?
   b. Did students understand interrelationships?

III. Equipment

1. 2 aquaria
2. 1 100-watt light source

IV. Procedures

1. Following textbook material on ecology, begin questions to generate discussion (1 - 2 class periods).
2. Following discussion, visit a local stream and collect enough aquatic weeds to cover about 2 square feet of water surface. Place half of the weeds in an aquarium full of water obtained from stream. Mount a 100 watt light bulb 1-2 feet above the aquarium. Do not aerate this aquarium (control). Place the other half of the weed sample in an identical setup in which water is aerated heavily. Observe both aquaria twice a week for several weeks.
3. Follow-up to laboratory procedures:
   Describe and account for any observed differences. What aquatic organisms seem to use the weeds as a habitat and/or food source? How do they respond to heavy aeration? Why?

USING GALLON JUGS AS AQUARIA, THE CLASS COULD BE DIVIDED INTO SMALLER GROUPS TO RUN CONCURRENT EXPERIMENTS. THIS WOULD ALLOW YOU TO BETTER CORROBORATE YOUR DATA. HOW DOES AERATION RELATE TO WATER QUALITY IN THE "REAL WORLD"?

Who Needs Water?

I. Introduction

Designed for students living in a lower socio-economic area; to aid them in realizing the degree that the environment affects water quality; grade level 2-4; awareness activity.

II. Questions

1. To lead to the activity:

   a. Must everyone consume water? Why?
   b. Have you ever gone without water for a "long" period of time? What did you feel - have you seen TV programs in which someone was deprived of water.?
   c. Would you drink muddy water?

2. To initiate the activity:

   a. Have you ever drunk water from areas other than your own?
   b. Did the water taste different? Why?
   c. Why do we have to add chemicals to drinking water?

3. To continue the activity:

   a. What is pollution?
   b. Have you ever seen pollution in streams and rivers around this area? What kinds?

4. To expand the activity:

   a. What are some of the effects of pollution you have seen?
   b. Do the results of pollution only affect humans? (GOOD EXPANSION IDEA)
   c. Is there anything you can do to help your community get rid of some of this pollution?
   d. What can your parents do?

5. To evaluate the activity:

   a. Did students understand what pollution is and its effects?

b. Do they know where it comes from?
c. Do the students perceive the relationship between water, pollution, and the environment?
d. Did they formulate any methods of control?

III. Equipment

1. Students
2. Slides of waterways
3. Glass jars

IV. Procedures

1. Homework - each student or group of students gather samples in jars - examine for pollution; or, bring in any example of a pollutant. (GOOD IDEA)
2. Take tap water sample - leave open to air for several days - examine residue after evaporation.

YOUR HOMEWORK IDEA IS A GOOD WAY TO CIRCUMVENT FIELD TRIP PROBLEMS.

Then And Now

This involves several trips to the Philadelphia Art Museum to view their collection of Thomas Eakins' studies of the Schuylkill River.

The students will then proceed to approximate sites of those paintings and drawings - and will execute their own drawings of the sites as they appear now.

A discussion and comparison of the ecological changes will then take place.

A critique of the drawings will end the lesson.

I have faithfully tried to incorporate as much environmental information as possible into these lessons, but one mustn't loose sight of the fact that this is an art situation and the main consideration must remain with the production of visual objects.

NEAT IDEA.

COULD A SERIES OF QUESTIONS BE DEVELOPED TO LEAD THE STUDENT TO THE "DISCOVERY" THAT OLD PHOTOS, PAINTINGS ARE A VALUABLE SOURCE OF DATA FOR COMPARISON TO CURRENT CONDITIONS?

What Are Ways To Measure Pollution?

I. Introduction

This activity will give students practice in developing observational powers and accurate measuring and recording of data. It is designed for eleventh grade chemistry students. It is primarily an awareness activity using observation, measurement and inference skills. It is assumed that students will have the necessary laboratory skills but not necessarily much knowledge on the causes or measurement of water pollution.

II. Questions

1. To Lead:

   a. Where, within a 10 mile radius of North Penn High School, are sites that might be good for the study of possible effects of water pollution?
   b. Why are these areas suitable for study?
   c. What characteristics are important to observe in the area?

2. To Initiate:

   a. How might we test water for dissolved oxygen, temperature, pH and chloride content?
   b. What might measurements of these characteristics tell us about the body of water?
   c. How long would it be necessary to study an area to gather reliable data?
   d. What kind of controls would you place on the experiment?
   e. What kind of equipment would you need?

3. To continue:

   a. How would you interpret the data you collect from these experiments?

4. To expand:

   a. Does the season of the year have any effect on the data you collected?
   b. What other substances might be interesting to test for?
   c. What might their presence in the water indicate?

5. To evaluate:

   a. What are the expected values for the characteristics you measured?
   b. What do the levels of the characteristics you measured possibly indicate about the water in your sample?
   c. How do observations at the site correlate with your data from the tests run?

III. Equipment

1. Hach test kit for dissolved oxygen or Winkler test materials.
2. Hach test kit for pH determination or suitable substitute.
3. Thermometers calibrated to $0.1^{o}C$.
4. $AgNO_3$, graduated cylinders, balances, for chloride determination.

IV. Procedure

1. Students should brainstorm, in class, ideas of places near their school that would be good to study as examples of possible water pollution.
2. They should organize into groups, each choosing a place to observe and collect water samples.
3. They would begin their study by compiling a complete observational record of the characteristics of the area.
4. Water samples should be collected, on several occasions, and tested for dissolved oxygen, pH, temperature, and amount of dissolved chloride (grams/CC H_2O).
5. Research should be completed by determining whether the EPA has established standards for these parameters.
6. A final report should be submitted by each group of students including their observations, data and the conclusions they have drawn from the experiment.

GOOD STUDENT INVOLVEMENT, BUT COULD THEY ALSO HAVE DETERMINED WHAT TESTS TO DO?

Dirty Words

I. Introduction

This activity is for students learning about water pollution. The grade level is 1-3. It is an awareness activity using rhyming and drawing skills.

II. Questions

1. To lead to the activity:

   a. Who knows what pollution is?
   b. What kinds of pollution have you seen?
   c. How does pollution make you feel?

2. To initiate activity:

   a. What things can become polluted?
   b. Can words tell others about pollution?
   c. Can you make up rhyming words about pollution?

3. To continue the activity:

   a. What kind of water pollution would you write a poem about?
   b. What kind of things does water pollution hurt?

4. To expand the activity:

   a. Can pictures help tell about water pollution?
   b. Have you ever seen a picture that warns about pollution? If yes, describe it.
   c. What will you draw to tell about your water pollution poem?

5. To evaluate the activity:

   a. Did the students poems make a point?
   b. Were the drawings appropriate for the poem?
   c. Did the students enjoy sharing their poems and drawings?

III. Equipment

1. Paper, craypas, blackboard, chalk, cartoon movie on water pollution.

IV. Procedure:

1. Show movie to class and briefly discuss what pollution is.
2. Help students find rhyming words about pollution. List on blackboard.
3. Give out paper and craypas.
4. Commence questions to generate activity.

INSTEAD OF SHOWING A MOVIE, WHY NOT TAKE A WALK: TO A LOCAL STREAM, TO A LITTERED PARKING LOT, TO AN ERODED HILLSIDE, TO A NOISY STREET, TO A HILL WITH A VIEW OF POLLUTED AIR? ANY RURAL ROAD SIDE WILL DO.

Water's Role

I. Introduction

This activity is to create an awareness of different means of generating electricity at different plant sites using varying power resources to create steam, or hydro energy. The primary goal is to understand the role water plays in each plant and how this water is treated upon intake, usage within the plant, and when it is returned to the river or lake.

This activity would involve an extensive field trip or trips to Cromby, Limerick Nuclear Information Center, Connowingo Hydroelectric Dam and Electric Plant and Muddy Run.

An awareness program for levels 1 & 2 (7th grade).

II. Questions

1. To lead to the activity:

   a. What different means of electric generation do you know of?
   b. How do these means of producing electricity vary in fuel consumption, and types of fuel used?
   c. What is the one natural resource that is common in all?

2. To initiate activity:

   a. How is water used in each plant?
   b. Is any damage done to the water?

3. To continue activity:

   a. By eyeballing is there any noticeable difference between pre-intake areas and post-water-release areas in the river?
   b. Does river flow seem to be affected?
   c. What might be the affect of reduced waterflow?

4. To expand activity:

   a. By taking samples of water before and after the plant sites can you detect a difference in the water and its make up?

b. Is there a measurable difference in river temperature at intake as opposed to where the water is released from the plant?
c. Why is it important to people to keep this water pollution free?
d. Why is it important to avoid thermal pollution?

5. To evaluate activity:

a. Are the students receptive to the idea of water usage in the different electric plants?
b. Are the students aware of possible sources of contamination at each plant site?
c. Are the students aware of the electric company's steps to avoid water pollution?
d. Are the students aware of the fact that the water may be heavily polluted before intake by the utility company?

III. Equipment

1. Field trip to electric generating stations. (Different types of stations)
2. Test tubes for water samples.
3. Labels for labeling test tubes.
4. Thermometer for measuring water temperatures.
5. Maps of different electric sites visited to indicate where samples were taken and conditions found there.

IV. Procedures:

1. Close cooperation with the science department on all testing.
2. Making sure the students understand the terms used in regard to electric production and to possible types of pollution.
3. Initiating questions to generate discussion.
4. Receiving permission for field trips (first procedure, the activity depends on this).

COULD THE STUDENTS DEVELOP A QUESTIONAIRE OR INTERVIEW FOR USE WITH OFFICIALS AT EACH OF THE SITES VISITED? TEST TUBES WILL NOT HOLD ENOUGH WATER FOR THE TESTS. LARGER CONTAINERS SHOULD BE USED.

A Fishy Question

I. Introduction

This activity is to help the student compare the fish population, around industries and away from them, so that the student can come to some conclusions about the water conditions.

II. Questions

1. To lead to the activity:

   a. What fish are in the Perkiomen Creek?
   b. What conditions affect the life of the fish?

2. To initiate the activity:

   a. What industries are located along the Perkiomen Creek?
   b. Do any of these industries dump waste into the creek?

3. To continue the activity:

   a. Are the industries affecting the fish population?
   b. How can we check it?

4. To expand the activity:

   a. Do we have to catch fish to check on the population?
   b. What is the best way to determine if the fish population has changed?

5. To evaluate the activity:

   a. Did the student come up with a way of checking the fish population?
   b. Did the students come to any conclusions?

III. Equipment

1. Students

IV. Procedure

1. Ask the students for the answers to the questions.

2. Let the students form groups to check the fish population.
3. Check results.

YOUR "QUESTIONS TO EXPAND" SEEM CENTRAL TO THE ACTIVITY AND THEREFORE SHOULD BE INCLUDED WITH QUESTIONS"TO CONTINUE". THE "TO EXPAND" SECTION IS TO SUGGEST FURTHER STUDIES.

DETERMINING A CHANGE IN FISH POPULATIONS PRE-SUPPOSES KNOWLEDGE OF PRIOR POPULATION SIZES, DATA COLLECTION OVER AN EXTENDED PERIOD OF TIME, OR DATA COLLECTED FROM A VARIETY OF SITES. QUESTIONS TO DEVELOP THE IDEA OF CHANGE MIGHT BE APPROPRIATE.

The Chlorinated River

I. Introduction

This is an awareness activity to develop the process skills of observing and comparing. The idea is to observe the effects of chlorine on aquatic life.

II. Questions

1. What are some possible effects of energy production on the water environment?
2. What are some of the things a power plant may do to affect the water environment?
3. How is this like putting your fish in city water?
4. What are some characteristics of plant or animal damage due to chemical pollution?
5. How could we design an experiment to test chlorine damage to aquatic life?
6. What do you expect will be the outcome of an experiment with a control, and an aquatic environment with chlorine present?
7. What do you observe of the two environments after the experiment?
8. What could be the effects of such problems on a large scale such as the chlorine which comes from the thousands of gallons of cooling water from power plants.
9. How do you think the electricity you use affects the water environment? Can we have energy and a good environment?

III. Equipment

Chlorox, two aquaria or jars, various aquatic plants and animals.

IV. Procedure

Ask: Have you ever put pet fish in city water? What happens?
Proceed with questions which lead to the experiment.

PLEASE INDICATE WHICH QUESTIONS ARE TO LEAD TO THE ACTIVITY, TO INITIATE, ETC. WHY NOT HAVE STUDENTS COLLECT THE ACTUAL EFFLUENT FROM A POWER PLANT FOR THE EXPERIMENT? WHY DO POWER PLANTS USE CHLORINE?

Water For Survival

I. Introduction

Designed for students living in a lower socio-economic environment. Introduction of water pollution. Level 2-4.

II. Questions

1. To lead to the activity:

   a. Who can name one thing we need to survive?
   b. Do plants need water to survive?
   c. Can people live without water? How long?
   d. How long have you ever gone without water?

2. To initiate the activity:

   a. Is all water safe to drink?
   b. Where do we get our drinking water?
   c. Does drinking water taste the same everywhere you go?
   d. What is the difference between spring water (fresh) and water we get out of the faucet?

3. To continue the activity:

   a. What is pollution? Can all types of pollution be seen?
   b. Have you ever seen polluted water?
   c. How can we change some polluted water into water safe to drink?
   d. Do you know what chemicals are used to make water safe to drink?

4. To expand the activity:

   a. What can we do to change some of the pollution in the water?
   b. How can our community get rid of some of our water pollution?
   c. Will polluted water harm our body?
   d. Let's examine some different types of water. (NOT A QUESTION)

5. Evaluate the activity:

   a. Observe if children were able to pick out the different types of water. (NOT A QUESTION)

b. Observe the children's reaction to questions. (NOT A QUESTION)

III. Equipment

1. Movie projector
2. Film on water pollution
3. 3 jars of water, one spring water, one water from faucet, and one polluted water.

IV. Procedure

1. Show film.
2. Ask questions.
3. Have children examine the three jars of water to determine the difference.

COULD THIS INDOOR ACTIVITY BE FOLLOWED BY ACTUAL VISITS TO THE VARIOUS SITES FOR FURTHER STUDIES? THIS IS VERY SIMILAR TO YOUR "WHO NEEDS WATER?" ACTIVITY. HOW COULD YOU MAKE IT DIFFERENT?

A Problem Of Values

A values clarifying activity for senior high school industrial arts/power technology students. Awareness level.

I. Introduction

Most decision making is based on a values judgment which is influenced by the collection of data on various alternatives. The purpose of this exercise is to have students examine their values on the relations between energy production and water pollution.

II. Activity Content

Select two films currently available from various sources which deal with the topics at hand. These films should represent the views of pro-energy production interest and pro-environmental concern interest. The films should be factual in nature and draw no conclusions. Show the films during the alloted time.

WHAT FILMS?

III. Activity Processing

Have each individual process each of the value questions below. After processing, have students come together in groups of five or six to discuss their individual responses. Emphasize the facts that there are no right or wrong answers, only value judgments.

IV. Process Questions

1. You are confronted with the opportunity of selling your family farm to a utility company which wishes to build a hydropower dam on the river which runs past your farm. You are holding out because of your sincere concern for the effects such a project will have on the river and surrounding land. The longer you hold out, the more financially attractive the utility makes it for you to sell. What choice do you make and why?

2. You are confronted with the facts that by blocking this project you are fostering a situation in which there will be an electric power shortage which will affect your entire region. Hydropower will provide a clean source of power as opposed to the utility

company's alternatives of building a coal burning steam turbine five miles up stream and directly upwind from your farm. Do these facts affect your decision making? How and Why?

FORMAT NEEDS ATTENTION.

WHY NOT USE QUESTIONS INSTEAD OF FILMS TO DEVELOP THE PROS AND CONS? OR VISITS TO ACTUAL SITES?

Drink The Water?

I. Introduction

This activity is for students entering a unit on pollution and the environment. The grade level is 8th.

II. Questions

Where can you get a drink of water? (exhaust possibilities). Can you drink from streams? Is there a place where you can safely drink from a stream? Why there? What are the sources of stream pollution? (make a list). What are the effects of water pollution? How can we detect water pollution? How can man stop water pollution? What can we do?

III. Procedure

At the end of the questioning students are asked to group themselves (3-8) and choose an activity from the following list:

1. Conduct simple pollution tests, record data, and make conclusions.
2. Design a pollution free community.
3. Design an anti-pollution program for this community.
4. Students may also engage in any related activity of their own design with teacher approval.

Each group will be expected to make a presentation of their project near the end of the pollution unit (2-3 weeks)

IV. Equipment

Drawing paper; equipment given to students according to project and need.

QUESTIONING SHOULD BE MORE FULLY DEVELOPED. EACH OF THE SUB-ACTIVITIES ABOVE COULD BE DEVELOPED (WITH QUESTIONS) AS A SEPARATE UNIT. TRY TO NARROW YOUR WRITING TO A SINGLE ACTIVITY.

What Do You Do With The Waste?

I. Introduction

This is an awareness activity for junior high students. It is also usable at the elementary level with some modifications. The purpose of the activity is to make students aware of water pollution problems and the systems for handling waste water.

II. Questions

A. Observation

1. Where does waste water go from your house?
2. What are the problems of waste water treatment?
3. Why don't all houses use the same method?

B. Initiate

1. How does your town or municipality handle waste water?
2. If your waste water does not go into a municipal treatment system, how is it handled?

C. Continue Activity

1. Why do some houses use septic systems while others use municipal systems to handle waste water?
2. Which system is more practical to install? maintain?

D. Expand Activities

1. Compare waste water treatment today with those of the past.
2. Why is waste water handled differently today than in past?
3. How does industry handle waste water?

E. Evaluation

1. Which method would you prefer in your house?
2. From the standpoint of the environment, which method has the least effect on the environment?
3. Will the same methods be as effective in the future?

F. Equipment

1. Resource pamphlets, persons from the community involved in these aspects of water quality control, and reference books in library.

G. Procedure

1. Have students find out where the waste water from their home is sent.
2. Bring resource people from the community to explain treatment and problems of waste water.
3. Bring resource people from the community to explain in-home septic systems.
4. Take a field trip to local waste water treatment plant to observe actual operation.
5. Take a field trip to a local industry to observe waste water treatment.

COULD THE STUDENTS HAVE A ROLE IN DETERMINING WHAT RESOURCES ARE NEEDED, WHICH PEOPLE TO CONTACT, AND WHICH SITES TO VISIT?

Energy Aliases

I. Introduction

This activity is for 11th and 12th grade Physics or Applied Science students. It is an awareness activity using categorizing, comparing, inferring, and questions.

II. Questions

1. To lead to the activity:

   a. What forms of energy are used in the home?
   b. Did you remember the lawn mower, the heat, your light?
   c. Which form of energy pollutes the least?

2. To initiate the activity:

   a. How is electrical energy produced from mechanical energy?
   b. What are the fuels used to produce this mechanical energy?

3. To continue the activity:

   a. What effect do you think these fuels have on the water in the rivers?
   b. What is thermal pollution?
   c. What is a cooling tower?

4. To expand the activity:

   a. What is the fuel for a hydroelectric plant?
   b. In what way does a hydroelectric plant pollute?
   c. What effects do you expect from a nuclear power plant?

5. To evaluate the activity:

   a. Did the students realize that electricity is the least polluting when used, but polluting when produced?
   b. Did the students know about thermal pollution and about cooling towers?
   c. Did they think that flooding of land is pollution?
   d. Did they overemphasize the danger of a nuclear plant?

III. Equipment

1. Pencil and paper
2. Reference materials

IV. Procedure

1. Have the student orally give answer to question 1.
2. Divide the class into groups of 4 or 5, and have them write up a group answer to question 2, 3, and 4.
3. Teacher can circulate reference materials among students as needed.
4. Individual groups report their findings to the class.

WHAT APPLICATIONS COULD THIS ACTIVITY HAVE TO "REAL WORLD" SITUATIONS AS OPPOSED TO LIBRARY-TYPE RESEARCH?

Generators Aren't The Only Thermal Polluters

I. Introduction

This is an awareness exercise for tenth grade biology students.

II. Questions

A. To lead to the activity:

1. What is pollution?
2. What types of pollution exist?

B. To initiate the activity:

1. How does water pollution affect you, relatives, and the community?
2. How does water pollution affect the state, country, and the world?

C. To continue the activity:

1. Can you think of any natural causes of water pollution?
2. Can you think of any man made causes of water pollution?
3. Does anybody know what thermal pollution of water is?
4. Why do you think power generation stations are located near water supplies?
5. What are some effects of thermal pollution?
6. How are the power companies beginning to control thermal discharges into water supplies?

D. To expand the activity:

1. Students would break up into groups.
2. Some groups would take temperature readings, plant and animal surveys above the school before the stream runs beneath the building.
3. Another group would do similar studies below the school where the water exits from under the building.
4. What have you learned about the thermal affects on our stream?
5. What can you do to help stop water pollution?

E. To evaluate the activity:

1. Do the students perceive what water pollution is?
2. Do the students perceive the different ways by which water is polluted?
3. Do the students understand the complexities of cleaning up the water supplies, both thermal and chemical?

III. EQUIPMENT?

IV. PROCEDURE?

FORMAT NEEDS SOME ATTENTION.

WILL THE STUDENTS HAVE AN OPPORTUNITY TO COMPARE THEIR SHCOOL SITE STUDIES WITH STUDIES OF AN ACTUAL GENERATOR SITE? WHAT HAPPENS TO THE WATER WHEN IT RUNS UNDER THE SCHOOL?

What's The Water Like?

I. To make students aware of water pollution problems.

II. Questions

1. To lead to the activity ask:

   a. When was the last time you swam or fished in a local stream or river?
   b. What was the water like?

2. To initiate the activity ask:

   a. What causes our water to get this way?

3. To continue the activity ask:

   a. Is this pollution caused by industry?
   b. Is it caused by people?
   c. Who causes the most?

4. To expand the activity ask:

   a. What can be done about water pollution?
   b. Are there things industry can do to prevent pollution:
   c. Are there things people can do to prevent pollution?

5. To evaluate the activity ask:

   a. What can you do to stop water pollution?
   b. What can we do to stop water pollution?

III. EQUIPMENT?

IV. PROCEDURE?

ACTIVITY NEEDS FURTHER DEVELOPMENT. COULD THIS SERIES OF QUESTIONS BE USED AT VARIOUS FIELD SITES TO DEVELOP STUDENT KNOWLEDGE AND INTEREST IN LOCAL SITUATIONS?

TRANSITIONAL LEVEL ACTIVITIES.....

Effects of Heat on Goldfish

I. Introduction

Making electricity may create three kinds of water pollution: Heat, mine drainage, and/or oil spills. At the power plant much of the heat in the stream is transferred to the condenser water. If this condenser water is returned to the river or lake from which it comes, the hot water may change the environment of the natural water and thereby affect organisms living in this water. This activity is a transitional activity designed to demonstrate the effect of heated water on goldfish. This activity can be used as an experiment for secondary students and as a demonstration for upper elementary students.

II. Questions

1. Questions which lead to the activity:

   a. What is water pollution?
   b. What are some common sources of water pollution?
   c. What are some of the effects of water pollution?

2. Questions to initiate the activity:

   a. How might heat affect a goldfish?
   b. How might you design an experiment to test the effects of heat on a goldfish?

3. Questions to continue the activity:

   a. Describe any changes you observe in the fish's behavior in heated water as opposed to room temperature water.
   b. How many "breaths" per minute did the goldfish have in warm water? in room temperature water?
   c. How would this affect the amount of dissolved oxygen and carbon dioxide in each water sample?
   d. What were the results of the D.O. test for each water sample?
   e. What were the results of the CO_2 test for each water sample?

4. Questions to expand the activity:

   a. How might heat affect other organisms?
   b. What can be done to remedy the situation?
   c. How will these remedies affect living costs especially the cost of electricity?

d. Are these remedies worth the extra cost?

5. Questions to evaluate the activity:

   a. Were students able to see the effects of heat on a goldfish?
   b. Were students able to suggest remedies to the situation?
   c. Do students realize the costs imposed by their alternatives?
   d. Do students realize there is no easy solution to the problem?

III. Equipment

1. Goldfish and fish net
2. Hach kit for D.O.
3. Hach kit for CO_2.
4. Baby food jars with lids
5. 2 large glass beakers or jars
6. Paper
7. Pencil
8. Thermometer
9. Distilled water
10. Hot water or alcohol burner or hot plate to heat water.

IV. Procedure

1. Fill baby food jar with distilled water.
2. Place goldfish in jar and seal with lid.
3. Put baby food jar in large beaker of room temp. water.
4. Allow jar to sit 2-3 minutes.
5. Observe behavior of fish and record.
6. Count breaths for 20 seconds (count mouth movement and/or gill movement). Record. (GILL COVER MOVEMENT)
7. After 15 minutes, remove jar and uncap fish.
8. Using Hach Kit perform D.O. test. Record results.
9. Using Hack Kit perform CO_2 test. Record results.
10. Place fish in second jar of distilled water and cap.
11. Put baby food jars in large beaker of water at 35° C.
12. Repeat above procedures.
13. Compare results.

A WELL DEVELOPED ACTIVITY. WILL DISTILLED WATER STRESS THE FISH?

Thermal Pollution-Effects on Bacterial & Fungal Populations

I. Introduction

This activity is designed for students in grades 7-12.

In this activity, students learn how or if thermal pollution from power plants affects the populations and types of bacteria and fungi. They learn to use various microbiological techniques.

The students are involved in formulating hypotheses, formulating methods by which to conduct the experiment, collecting data, pooling data, and processing data. Students also predict how their findings about bacteria and fungi relate to other living things. Students evaluate how meaningful their data is.

This experiment is on the transitional level.

II. Questions

1. To lead to the activity:

   a. What is thermal pollution?
   b. How does thermal pollution affect living things?

2. To initiate the activity:

   a. What type of organisms could be easily collected from rivers in order to study thermal pollution effects?
   b. How are bacteria and fungi cultured in a laboratory?
   c. From what areas of a river that has a power plant should we collect samples?
   d. How many samples should we collect?
   e. What other observations must we make at the collection site in order that we have the necessary data to analyze our findings? Do we need temperature differences?

3. To continue the activity:

   a. How many colonies grew on the agar with water from each site?
   b. How many different types of colonies did you find?
   c. Were there more molds than bacteria at certain sites?

d. Were there different types of bacteria and fungi at the different temperature sites?

4. To expand the data:

a. Were the differences in populations of bacteria and fungi due solely to differences in temperature of the water?
b. Were there other variables?
c. Do we have enough data to draw conclusions?
d. How might we add to or varify this data?
e. If the bacteria or fungi are affected by thermal pollution, is there any effect on the food web in that area of the river?
f. What do you predict will happen to the area of a river near a power plant?

5. To evaluate the activity:

a. Were students able to propose a method to collect data?
b. Were students able to carry out lab procedures?
c. Were students able to criticize methods of collecting data and propose improved methods?
d. Did students understand the effect of disrupting a food web?
e. Were students able to hypothesize?
f. Were students able to tell bacterial and fungal colonies apart?
g. Were students able to work together outside a classroom situation?

III. Equipment

1. Agar (nutrient, enriched)
2. Hot plates
3. Plastic petri dishes
4. Pipettes
5. Thermometer
6. Water collecting bottles

IV. Procedures

1. Introduce the activity by initiating class discussion
2. Initiate the activity by using questions that will lead the class to discover a procedure that will enable them to collect water samples and determine types and populations of bacteria and fungi.
3. Continue the activity by allowing students to collect samples of water 10 miles above a power plant, 10 miles below a power plant, and at the power plant. Students will also record water temperatures for all samples when they are taken.

In the laboratory, students will mix (1 ML) of a sample with (9 ML) of melted, sterile, nutrient agar, using pour plate technique. After 2 days, students will count numbers and types of colonies on each of their plates.

4. Students will expand this activity by considering questions proposed. They will process data and look for meaningful trends by compiling class data. They will discuss ways to expand or bring more meaning to their data.

FINE USE ~~OF THE~~ QUESTIONING APPROACH.

CONCERNING THE SAMPLE COLLECTED AT THE POWER PLANT:
TRY TWO SAMPLES, ONE IMMEDIATELY ABOVE THE EFFLUENT SITE,
AND ONE DOWNSTREAM OF THE OUTFLOW.

Water Temperature Vs. Dissolved Oxygen

I. Introduction

This activity is designed to help junior high students collect and interpret data concerning the amount of dissolved oxygen and how this is affected by temperature change. It would be a particularly significant study if it were to be done in waters affected by power plants and other industrial sites.

II. Questions

A. Questions that lead to the activity:

1. How does temperature of water affect the amount of dissolved oxygen in that water? (THIS QUESTION COULD BEST BE ANSWERED AFTER THE EXPERIMENT)
2. Why are environmentalists concerned about this fact?

B. Questions that initiate the activity:

1. How could we detect and compare the amount of dissolved oxygen in water?
2. How does the amount of dissolved oxygen in 10 ml of water at $100^{o}C$ compare to the amount in 10 ml of water at $5^{o}C$?

C. Questions that continue the activity:

1. What areas in our community would have water of different temperatures?
2. How does the amount of dissolved oxygen compare when samples of water are taken upstream, or away from where water is discharged at a different temperature, to samples taken below this discharge?
3. How does the sample from upstream compare in amount of dissolved oxygen to that taken at the point of discharge?
4. How does the sample from downstream compare in amount of dissolved oxygen to that taken at the point of discharge?

D. Questions that expand the activity:

1. Does difference in depth affect the amount of dissolved oxygen?

2. Does the fact that water is standing or moving affect the amount of dissolved oxygen found in that water?
3. Does the amount of shade on a stream affect the temperatures and thereby the dissolved oxygen?

E. Questions that evaluate the activity:

1. Was evidence found that would concern environmentalists about the amount of dissolved oxygen in water? If so, what was this evidence?
2. Could you think of ways that this concern of environmentalists could be dealt with?
3. Would your solution to question 2) affect you or the community in any way? If so, how?
4. Are there other factors besides temperature that could affect the amount of dissolved oxygen in water? If so, what are they?

III. Equipment

1. Field kit for Winkler Test
2. Jars for collecting samples
3. Thermometer
4. Graduated cylinder or other equipment for measuring amount of water.

IV. Procedure

Check the answer to Part II, B, Question 2, in the lab. Then after deciding upon sites from which samples are to be taken, do the Winkler Test at the field site. Be sure to use the same amount of water sample each time.

FOR QUESTION B-2, START WITH STREAM WATER AND CHECK OUT SEVERAL POINTS BETWEEN AMBIENT AND 100°C. IF YOU COOLED 100°C WATER DOWN TO 5°C, D_O WOULD PROBABLY BE VERY LOW.

Effect Of Thermal Pollution On Dissolved Oxygen

I. Introduction

This is a transitional activity for junior high. The students are already aware that the production of energy may lead to thermal pollution of water. The students will predict, collect, process and evaluate data, and formulate an hypothesis.

II. Questions

1. To lead to the activity:

   a. What effect may heat have on the physical characteristics of water in a stream?
   b. What effect may heat have on the biological characteristics of a stream?

2. To initiate the activity:

   a. What physical characteristics would be most important to life in the stream?
   b. How can we find out what effect heat has on the amount of oxygen dissolved in water?

3. To continue the activity:

   a. How would the dissolved oxygen in a stream upstream from power plant discharge compare with the dissolved oxygen downstream from the discharge?
   b. Are all forms of life in the stream affected equally by a decrease in dissolved oxygen?
   c. What different forms of life might you expect to find in a stream in the Poconos and a stream in Philadelphia?

4. To evaluate the activity:

   a. Were the students able to use the LaMotte Kits effectively?
   b. Were the students able to determine from their data the effect of heat on dissolved oxygen?
   c. Were the students able to determine a relationship between dissolved oxygen and life in the stream?

III. Equipment

1. LaMotte Kit for testing dissolved oxygen.

2. Tap water.
3. Alcohol burners
4. Beakers
5. Thermometers
6. Pencil and paper
7. Chalkboard and chalk

IV. Procedures

1. Have class predict the effect of heat on dissolved oxygen.
2. Divide the class up into groups of about 6.
3. Have each group collect 2 sample bottles of room temp. tap water.
4. Record the temperature of the samples.
5. Heat one sample 5^{o}C in a water bath.
6. Allow the other sample to remain at room temp. during this time.
7. Test the dissolved oxygen of both samples with the LaMotte Kit.
8. Record the results of all the groups on the chalkboard.
9. Using a histogram, compare the results for the heated and unheated samples.
10. Using the data, the class will formulate an hypothesis concerning the effect of thermal pollution on dissolved oxygen in water.
11. Continue discussion of the effect of thermal pollution on life in a stream.

WHAT ABOUT QUESTIONS TO EXPAND? COULD STUDENTS COLLECT SIMILAR DATA FROM SUSPECTED THERMAL SITES FOR FURTHER COMPARISON? YOU MIGHT TRY MORE THAN THE TEMPERATURES.

Breathing Hot Water

I. Introduction

It is known that all types of steam powered plants discharge unusable heat. This is an activity to make students aware of some of the consequences of thermal discharge. The grade level is 7-9 and it uses observational and measuring techniques.

II. Questions

1. To lead to the activity:

   a. If you had some water which you wished to be rid of, what would you do with it?
   b. If factories have water which is unwanted, what do they do with it?
   c. What is the path of the unwanted water of which you and the factory rid yourselves?
   d. What types of living organisms are in the path of this unwanted water?

2. To initiate the activity:

   a. If a power plant uses water to cool down its steam, what happens to the water?
   b. If this plant no longer wants the used water, where will it go and what will it do to its surroundings?
   c. What are some of the organisms in the environment which might be affected by the waste water?

3. To continue the activity:

   (Students record number of times fish's gill coverings open and close per minute at various temperatures).

   a. A fish is cold blooded. What does this mean?
   b. To what is the opening and closing of the gill covers related?
   c. Did you observe a relation in the number of openings and closings and the temperature of the water?
   d. What effect does a change in temperature have on a fish?

4. To expand the activity:

   a. If you have a tropical fish aquarium, what equipment do you have?

b. What temperature, approximately, would you make the water if you had a fish from North Africa? from the Schuylkill? from the Pocono Mountains?
c. If you had a large tank with the water near the one end at 55°F and at the other end at 70°F, to which end do you think a brook trout would swim?
d. Do you think thermal discharge could change the type of fish in a stream?
e. What are some other effects, good and bad, which might come about because of thermal discharge?

5. Evaluation

a. Did students understand what thermal discharge from a factory is?
b. Were students able to record the data in a table properly?
c. Did the students perceive several consequences of thermal discharge?

III. Equipment

1. Fish tank
2. Fish (goldfish, sunfish).
3. Thermometer
4. Heater

IV. Procedure

a. Do questions (parts 1 & 2).
b. Have students observe a fish and record the number of times per minute the gill covers open and close. Take recordings in 5°F intervals from a water temperature from 40°F to 85°F.
c. Commence questions (part 3).

COULD YOU LOCATE AN AREA WITH A THERMAL DISCHARGE AND ACTUALLY SAMPLE THE TYPES OF FISH AND THEIR TEMPERATURE PREFERENCES?

Brine Shrimp - A Feathery Barometer

I. Introduction

The quality of aquatic life is dependent upon many factors which vary continually. From time to time, man will cause variation in one or more of these factors. Is it possible to study one organism in order to draw some conclusion concerning man's effect on the aquatic environment.

II. Questions

A. Lead

1. What is meant by the term ecosystem?
2. Is it possible to subdivide this system into regions according to the type of life living in the region?
3. Would those organisms living part or all of their life in the water fit into such a subdivision?
4. What are the basic needs of any living organism?

B. Initiate

1. What are the basic needs of aquatic organisms?
2. What types of food do these organisms need?
3. How does nature supply these needs?

C. Continuing

1. How does man disrupt nature's supply line?
2. What are the effects of man's activity?
3. What are the materials most often blamed for changing the aquatic environment?

D. Expanding

1. What type of organisms do Biologists use to measure the effects of man-made pollution?
2. How might they go about measuring the effects of man's pollution on these organisms?
3. How could you do an experiment to test the effects of these forms of pollution on an organism such as brine shrimp?
4. What is the purpose of experimental controls?

E. Evaluation

1. Were the students able to design a logical, workable

experiment using brine shrimp?
2. Was there a variety of factors discussed and investigated ?
3. Were the results in keeping with established experimental results?
4. Were the students able to draw conclusions from the results of their experiments?
5. Was there an orderly evaluation of man's impact on the aquatic environment?
6. Was this evaluation rational or environmentalistically biased?

III. Equipment

1. Jars
2. Thermometers
3. Heaters
4. Refrigerators
5. Lights
6. Brine shrimp

IV. Procedure

1. Lead the students to a point where they must consider the possible changes in the environment that man can cause.
2. Have the student design at least one experiment to test the effects of one change.
3. Combine the results from experiments testing the same change and draw conclusions.

YOUR "EXPANDING" QUESTIONS WOULD MORE PROPERLY BE LABELED "CONTINUING" AS THEY ARE CENTRAL TO THE DEVELOPMENT OF THE ACTIVITY. "EXPANDING" QUESTIONS NEED ONLY SUGGEST FURTHER STUDIES. WHY NOT USE NATIVE ORGANISMS (SUCH AS DAPHNIA)?

Thermal Effects

I. Introduction

Many types of electrical generators produce steam to run generators. The steam has to be cooled, so river water is used and in many cases, the water is returned to the river at a higher temperature than it went into the plant.

This experiment is designed to simulate that thermal increase. The set up requires two identical aquariums, one 10^{0} warmer than the other.

The students are then to determine if there are any differences between the two aquariums and to draw some conclusions.

II. Questions

1. Do you predict any differences between the reactions of the organisms in aquariums? If so, what?
2. Identify the fish numbers of each type and the conditions of the fish in both aquariums.
3. Take samples of the water and find out how many different types of organisms are in the water of each aquarium?
4. Take 4 similar sized rocks out of each aquarium. Determine how many different types of organisms there are and how many of each type there are on the rocks.
5. Compare your data for each aquarium. Do you see any similarities? Any differences? What are they?
6. What is your explanation of your results?

Material:

1. Two aquariums of the same size, two heaters & pumps, 2 thermometers.
2. Naturally occurring stream flora & fauna (each aquarium gets similar amounts of each organism).
3. Mud, gravel and rocks from stream.

Procedure:

Set up aquariums so each is subject to the same environmental conditions. Place similar amounts of organisms and physical substrate in the aquariums. One heater is to be set ten degrees warmer than the other. Allow the aquariums to sit in the set up condition for 2 weeks before you begin with the students using the materials.

WHY NOT LET STUDENTS SET UP AQUARIA? PLEASE INDICATE WHICH QUESTIONS ARE TO LEAD TO, ETC. WHY NOT COLLECT YOUR DATA FROM THE "REAL" WORLD IN "REAL" STREAMS WITH "REAL" THERMAL PROBLEMS? BE CAREFUL NOT TO TEMPERATURE SHOCK THE ORGANISMS.

Electricity and Water Pollution

I. Introduction

This activity is for students unfamiliar with the water pollution problems associated with the generation of electricity. It is for the senior high school level. It is a transistional activity, using data collection.

II. Questions

1. To lead to the activity:

   a. What method of generating electricity is the most interesting to you?
   b. Using this method, how is electricity produced?

2. To initiate the activity:

   a. What are some of the uses water has in this method of electric generation?
   b. Where is the water obtained from?
   c. What is done with the water after it's used?

3. To continue the activity:

   a. Which parts of the generating process might be considered to be polluting the water?
   b. What factors are responsible for the pollution?

4. To expand the activity:

   a. What are the possible results if the plant pollutes the water?
   b. What can be done to prevent the pollution of the water?
   c. Are there any laws which govern what pollutants and how much of them can be left in the water?
   d. What agencies are responsible for checking that the water is not polluted beyond specified limits?

5. To evaluate the activity:

   a. Did the students perceive the problems with water pollution that the power plant would encounter?
   b. Were the students able to find the solutions to the sources of pollution?

III. Equipment

1. References on energy and electricity.

IV. Students would initiate research in their particular area of generation. To end the activity, a concluding discussion would be held involving various pollution problems and their solutions for each type of generating plant.

WHAT ABOUT SOME ACTIVITY IN THE "REAL" WORLD? THIS LOOKS LIKE A LIBRARY PROJECT. TRY GETTING THE KIDS INTO THE FIELD TO COLLECT DATA AT VARIOUS GENERATING SITES.

ENERGY AND AIR POLLUTION

Page No.

AWARENESS LEVEL ACTIVITIES:

Air Pollution: Coal Vs. Atomic Power Plants.... 99
Effects Of Air Pollution On Nylon..... 102
Eyeballing The Air..... 104
Ugly Air..... 106
Design And Change Operations In Drawing..... 108
Your Air To Breathe..... 110
Ozone And The Rubber Band..... 112
The Concentration Of Ozone In The Air..... 114
Effects Of Sulfur Oxides..... 116
Schoolyard Air..... 118
Can You See?..... 120
Production Pollution..... 122
Air Pollution And Beans..... 123
Energy Can Pollute, Before, During, And After... 124

TRANSITIONAL LEVEL ACTIVITIES:

Toilet Tissue Can Help..... 127
Cloth Rot..... 129
Coal-Black Diamond Or Time Bomb..... 130
Local Air Survey..... 132
Air Effects..... 133
Would You Like To Live There?..... 135

OPERATIONAL LEVEL ACTIVITY:

Do Little Power Companies Pollute Too?..... 137

AWARENESS LEVEL ACTIVITIES.....

Air Pollution: Coal Vs. Atomic Power Plants

I. Introduction

In this activity students will compare amounts of air pollution from three areas: near an atomic plant, near a coal fired plant, away from any type of plant or industry. The pollution will be collected on filter paper and observed.

This activity is at the level of awareness and is suggested for students in grades 5-10. Students will become more aware that there are different types of electric generating plants. and that there are certain dangers involved with each.

Skills in observing, comparing, measuring, inferring, and questioning are developed. Simple laboratory skills such as using a scale, microscope and pH paper are also used.

II. Questions

1. To lead to the activity:

   a. What do you know about air pollution?
   b. What does air pollution do to you?
   c. Where does air pollution come from?
   d. What chemicals are a part of air pollution?

2. To initiate the activity:

   a. What types of plants produce electricity?
   b. Do these plants give off air pollution?
   c. Do you think atomic plants or coal-burning plants produce more air pollution?
   d. Which do you hear more about, atomic or coal plants?

3. To continue the activity:

   a. How can we determine which type of electric generating plant produces more air pollution? What kind of observations can we make?
   b. Is there an easy way to measure differences in amounts of air pollution?
   c. How do pieces of filter paper collected from all three areas compare to each other?
   d. Do the particles on all 3 pieces of filter paper appear the same in the microscope?
   e. How do the pH's of the different samples compare?
   f. Did all members of the class find the same results?

4. To expand the activity:

   a. Is one kind of power plant more air polluting than another?
   b. Is one kind of power plant more dangerous than another?
   c. What else would you want to know before you answer this question? Who could we ask?
   d. Would you rather live near an atomic powered or coal powered electric generating plant?
   e. Have you heard about other dangers associated with atomic plants?
   f. How does air pollution affect other organisms, such as plants & other animals, besides man?

5. To evaluate the activity:

   a. Were students able to work dilligently outside the classroom?
   b. Were students successful in observing?
   c. Were students able to use a balance?
   d. Did student compare samples from all three areas as well as samples in the same area collected by other students?
   e. Did students formulate questions they would like to find answers to concerning types of electrical power generation and the air?
   f. Did students become more aware of problems involved in electric power generation and air pollution?
   g. Did students find these problems relevant to themselves?

III. Equipment

Filter paper, masking tape, distilled water, microscopes, litmus paper, scales (balances).

IV. Procedure

1. Each student will be given 3 pieces of filter paper which he will weigh and record weight. One piece will be taped to an exposed area near a nuclear powered electric generating plant. One piece will be exposed in an area near a coal powered electric generating plant. The last piece is exposed in an area with no industry.
   Students attempt to place paper in equally exposed areas at equal distances from the plants for the first two pieces.

2. Paper is left exposed for 2 weeks and collected. Each student reweighs and records his new weight and finds weight of residue. The residue is observed with microscopes and observations are recorded.
3. Students mix residue with water for each of 3 samples. They take and record pH for all 3 samples.
4. All members of the class report their data to the rest of the class and compare findings.
5. Questions are asked before actual lab work begins to lead to the activity. Students' interest is stirred. Students answer questions about nuclear and coal powered electric generating plants when the activity is initiated. To continue the activity, students answer questions that allow ways of determining air pollution. They continue by actually going into the field and performing tests. They compare results and question each other. The activity is expanded when students discuss their findings and answer other "leading" questions.

GOOD ACTIVITY.

WHEN PLACING YOUR PARTICULATE SAMPLERS, YOU MAY WISH TO PROTECT THEM FROM RAIN OR EXCESSIVE WINDS, WHICH MIGHT REMOVE PREVIOUSLY DEPOSITED PARTICLES. WHATEVER TECHNIQUE YOU CHOOSE, IT SHOULD BE USED UNIFORMLY THROUGHOUT YOUR SAMPLING PROJECT.

BEFORE YOUR FINAL WEIGHING, IT MAY BE NECESSARY TO DRY YOUR FILTERS AS THEY MIGHT ABSORB WATER FROM THE RAIN OR HUMIDITY.

SHOULD SOME ATTENTION BE GIVEN TO PREVAILING WIND DIRECTIONS RELATIVE TO THE SAMPLERS' LOCATION IN RELATIONSHIP TO THE PLANT?

Effects Of Air Pollution On Nylon

I. Introduction

When energy is used to produce electricity, the environment is also changed. Whether the environment is changed in large or in small ways depends on the fuels burned and the pollution control equipment in the plant. Air, land, and water quality may be affected as electricity is made. Burning fuels release gases, particles of burned fuel and heat. Some of these products of burning fuels have little or no effect on air quality while others may damage human, animal, and plant health and may change the environment. This investigation is an awareness activity designed to demonstrate that air pollution can also damage non-living materials. This activity can be used at various grade levels (4-12), with modifications, as part of an air pollution unit.

II. Questions

1. Questions which lead into the activity:

   a. What is air pollution?
   b. What are some common sources of air pollution?
   c. What are some of the effects of air pollution?

2. Questions to initiate the activity:

   a. Does air pollution affect only living things?
   b. How can air pollution affect non-living things?
   c. How might you design an experiment to test the effects of air pollutants on non-living things?

3. Questions to continue the activity:

   a. What is the effect of certain types of air pollution on an everyday item of wearing apparel such as nylon goods? after a week, month, etc.?
   b. How might you test the effects of air pollutants on nylon?
   c. What common wearing apparel is made of nylon?

4. Questions to expand the activity:

   a. Can air pollution have a direct bearing on family living costs? Explain your answer.
   b. What can be done to remedy this situation?
   c. How will these remedies affect living costs?

5. Questions to evaluate the activity:

   a. Were students receptive to the idea of air pollution affecting non-living materials?
   b. Do students realize how air pollution affects their family living costs?
   c. Were students able to suggest remedies to this situation?
   d. Do students realize the costs imposed by their alternatives?
   e. Do students realize there is no easy answer to the problem?

III. Equipment

1. Good quality (15 denier) nylon hose.
2. Standard polaroid slide mounts #633, sixe 3¼" X 4" or other suitable mounts (may be homemade)
3. Scissors
4. Paper
5. Pencil
6. Slide projector and screen or low-power microscope or magnifying glass.
7. Wood blocks.

IV. Procedure

1. Cut a square piece of the nylon hose of sufficient size for the slide mount.
2. Stretch it over 1/2 of the mount and glue it. Place between the two halves of the mount.
3. Prepare at least 3 samples in this manner.
4. Place the mounted nylon on wooden blocks so that air can come in contact with both sides of the nylon. Place in an unobstructed safe place on the school roof (or other suitable place) with nylon in a horizontal position.
5. Place a second sample on roof in a shelter of some type.
6. Place the third sample in a closed container. Keep in lab.
7. Examine samples weekly for broken threads. Record.
8. Continue weekly observations for at least 2-3 months.

GOOD ACTIVITY

Eyeballing The Air

I. Introduction

Activity to generate knowledge of ways in which industries and modern technology causes air pollution, and methods to alleviate; grade level 2-4; awareness activity.

II. Questions

1. To lead to activity:

   a. What does air smell like? Should clean air have an odor?
   b. Why does it smell sometimes? Can it smell good?
   c. Can you see air? Should you be able to?

2. To initiate the activity:

   a. What are some odors you smell in the air?
   b. What do you see in the air?

3. To continue the activity:

   a. Do the odors and things you see have to be there?
   b. Where do they come from?

4. To expand the activity:

   a. What is air pollution?
   b. Can the causers of air pollution do anything about it? What?
   c. Have you or your parents ever contributed to air pollution? How?
   d. What can you do to help clean the air - What can industries do to help? What if we do nothing?
   e. Are there any laws that people have to obey pertaining to pollution control?

5. To evaluate the activity:

   a. Did students understand what air pollution is? How it is caused?
   b. Do they see the need to alleviate air pollution on the environment and the population?
   c. Did they think it's important that air pollution must be controlled?

III. Equipment

1. Students and their senses.

IV. Procedures

1. "Eyeball" the atmosphere.
2. Initiate a discussion around the results of "eyeballing".

COULD YOUR EYEBALL TESTS BE DONE AT DIFFERENT SITES OR DIFFERENT TIMES TO GIVE THE STUDENTS A BASE OF COMPARISON? COULD THEY ALSO RECORD THEIR FINDINGS: IN WORDS, IN PICTURES, ETC.

Ugly Air

I. Introduction

This activity deals with air and some of the ugly results of air pollution. It is an awareness activity for those who have never dealt with air pollution.

II. Questions

1. To lead activity:

   a. This picture of a city was taken from an airplane. Can you find and circle where the smoke is coming from?
   b. What makes the air look gray and dirty?
   c. What else puts smoke in the air?

2. To initiate the activity:

   a. What would happen to people if the wind could not blow away large clouds of pollution?
   b. Can dirty air hurt anything else? What?

3. To continue the activity:

   a. These are pictures of "other"things destroyed by the gases in dirty air. Can you see where they are harmed? What signs did you look for?
   b. Dust and ashes in air pollution can make buildings dirty. Can you find and circle areas hurt by pollution?

4. To expand the activity:

   a. Is dirty air bad for green plants?
   b. This is a picture of a healthy pine tree. How can you tell?
   c. This is a picture of a pine tree growing near a busy highway. How do you think it was hurt?
   d. To stay healthy a plant needs water and a lot of sunlight. What would happen if air pollution stopped the sunlight from reaching the plants?

5. To evaluate activity:

   a. Were the students helpful in identifying pollution.

b. Did they understand the potential harm of air pollution?

III. Equipment

1. Pictures of air polluted areas.
2. Pictures of healthy and non-healthy plants.

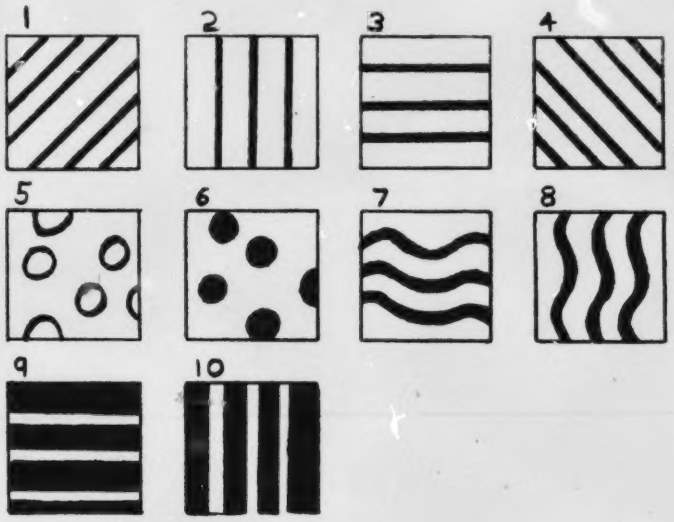
IV. Procedure:

1. Show pictures one at a time.
2. Begin questions to stimulate discoveries and observations about the pictures.

ON A FIELD TRIP OR AS A HOME WORK ASSIGNMENT, COULD YOU ASK THE STUDENTS TO PHOTOGRAPH OR SKETCH AIR POLLUTION PROBLEMS? THESE RECORDS OF THEIR OWN ENVIRONMENT COULD BE MORE MEANINGFUL THAN PICTURES OF SOME ANONYMOUS AREA.

Design And Change Operations In Drawing

I. Students must do a series of 10 similar but different designs on 4"/4" construction paper. Example:



The color choice is similar. The pattern is different. Negative/positive space.

Students should assign a number from 1-10 to the drawings.

II. Students then will obtain information from public agencies/ or their science classes on the air pollution count (on a scale of 1 to 10) for a period of 9 days.

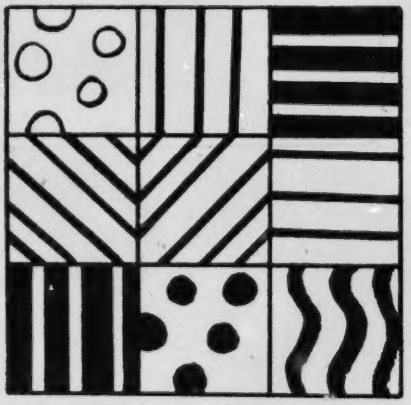
III. With this information they will then do a drawing by assembling and matching day, pollution count, and design.

1st day - P.C. - 5
2nd day - " - 2
3rd day - " - 9
4th day - " - 4
5th day - " - 1
6th day - " - 3
7th day - " -10
8th day - " - 6
9th day - " - 8

117

THIS SOUNDS LIKE AN INTERESTING WAY TO GRAPHICALLY PORTRAY DAILY VARIATIONS IN POLLUTION CONDITIONS. SHOULD QUESTIONS BE EMPLOYED TO FURTHER THE STUDENTS' UNDERSTANDINGS OF THE RELATIONSHIPS OF VISUAL COMMUNICATION TO VERBAL OR NUMERICAL DATA? ARE OUR FEELINGS/ATTITUDES AFFECTED BY ANY PRIOR KNOWLEDGE OF THE SUBJECT AT HAND OR BY PREVIOUS RANDOM ASSOCIATIONS WITH COLOR OR SHAPE? HOW CAN WE BEST COMMUNICATE OR RECORD OUR KNOWLEDGE OF AIR POLLUTION CONDITIONS? COULD THIS ACTIVITY LEAD THE ART CLASS TO A SCHOOL OR COMMUNITY PROGRAM TO FURTHER THE PUBLIC'S AWARENESS OF THE POLLUTION SITUATION?

1ST DAY	2ND DAY	3RD DAY
4TH DAY	5TH DAY	6TH DAY
7TH DAY	8TH DAY	9TH DAY



Your Air To Breathe

I. Introduction:

This activity is designed to familiarize seventh grade level one and two students with air pollution within their town or township (Conshohocken and Plymouth Township). This is an awareness activity.

II. Questions

A. To lead to activity:

1. What is air pollution?
2. Where is air pollution commonly found?
3. What causes air pollution?

B. To initiate activity:

1. Search out your area tonight for source of air pollution.
2. What types of air pollution have you discovered? (Factory, auto, etc.)

C. To continue the activity:

1. Let us plot on maps of Conshohocken and Plymouth Township the areas of air pollution contributors you have discovered.

D. To expand activity:

1. Using the maps we have plotted which areas seem to be most densely polluted?
2. Let's label the polluters on the map.
3. What types of pollution do you feel each is contributing to your air?
4. Using our air pollution density maps take samples of the air in the seemingly high pollution areas (In cooperation with the science dept.).
5. Industrial speakers.

E. To evaluate activity:

1. Are the students more aware of air pollution in Conshohocken and Plymouth Township?
2. Do students understand the possible adverse effects of air pollution?
3. Are students aware of the different contents (makeup) of air pollution?

4. Are the students able to formulate a hypothesis for possible solution to some air pollution problems?

III. Equipment:

1. Maps of Conshohocken and Plymouth Townships.
2. Personal sightings (eyeballing) of air polluters by students.
3. Toilet paper.
4. Cameras and slides.
5. Masking tape and jars.
6. Vaseline
7. Pinto beans
8. Industrial speakers.

IV. Procedures:

1. Initiation of questions to generate discussion on air pollution. What is it? Where is it? Why is it?
2. Supply maps to plot high density air pollution areas in town and township.
3. Enlist the help and cooperation of the science department.
4. Supply slides of area.
5. Supply speakers on air pollution.
6. Supply equipment needed for testing during the activity.

YOUR "QUESTIONS" AREN'T ALL QUESTIONS. YOU SHOULD USE QUESTIONS TO HELP THE STUDENTS COME UP WITH THE VARIOUS SAMPLING DEVISES. THEY MAY BE ABLE TO DEVISE APPROACHES THAT HADN'T OCCURRED TO YOU.

Ozone And The Rubber Band

A. Introduction

This activity is for students to become more aware of the air around them. They will also be introduced to ozone and where it can come from. Grade level - 6th. Awareness activity using observing, comparing, and inferring.

B. Questions

1. To lead to the activity:

   a. What is air pollution?
   b. What causes it?

2. To initiate the activity:

   a. Can you tell when air is being polluted?
   b. How can you tell?
   c. Can you always tell?

3. To continue the activity:

   a. What happened to the rubber bands?
   b. Why do you think they broke?
   c. Did you see anything that might have caused it to happen?

4. To expand the activity:

   a. Where did "it" come from?
   b. Why didn't all the rubber bands break at the same time?
   c. Where and how could we find out what it was that caused the rubber bands to break?

5. To evaluate the activity:

   a. Do the students have a fair understanding of what air pollution is?
   b. Could they find out what caused the experiment to happen?

C. Equipment

1. 3 small pieces of wood.

2. 6 nails
3. hammer
4. 3 rubber bands
5. 3 appliances of different sizes (ex: - mixer, fan, refrigerator)
6. Reference books.

D. Procedures (1 or 2 class periods)

1. Discuss leading and initiating questions.
2. Perform the experiment. Into a small piece of wood, hammer 2 nails and stretch a rubber band between them. Make 3 of these. Set them near 3 appliances of different sizes. The rubber bands will crack and break in the presence of ozone. The time it takes depends on how much ozone is present. (Electric motors generate ozone).
3. Discuss continuing and expanding questions.
4. Research to find out what caused the breakage of the rubber bands.

IN THE INITIATION SECTION COULD YOU ASK QUESTIONS ABOUT RUBBER BAND BREAKAGE TO INTRODUCE THE CONCEPT OF YOUR SAMPLER? THE EXPANSION QUESTIONS COULD BETTER BE PLACED IN THE CONTINUATION SECTION. USE THE EXPANSION PART TO LEAD THE STUDENTS TO STUDIES OF OTHER TYPES OF AIR POLLUTION.

The Concentration of Ozone In The Air

I. Introduction

This activity is designed to make junior high students aware that unseen gases in the air (such as ozone) are pollutants and do not come only from industry, but from our very own homes.

II. Questions that lead to the activity:

a. What is ozone gas?
b. Where does it come from?
c. What effects does it have on plant life?
d. What effects has it on such substance as rubber?

III. Questions that initiate the activity:

a. If we know how ozone affects plants and rubber, how can we use this knowledge to detect its presence?
b. Which of the two items in the above question would be the more convenient one to use?

IV. Questions that continue the activity:

a. What areas in your home would be good areas to set up our detectors? Why do you say so?

V. Questions that expand the activity:

a. What areas outside the home would be good areas to set up detectors? Why do you say so?
b. What areas in the school would be good areas for setting up detectors? Why do you say so?

VI. Questions that evaluate the activity:

a. What areas proved to be good sources for ozone? How do you know this?
b. Where would we be most likely to find even larger concentrations of ozone? Why do you say so?
c. Other than the damage it can do to plants, where else is ozone a concern and why?

VII. Equipment

a. For each area set up use one block, 2 nails, and one rubberband.

VIII. Procedure

On each block, nail two nails the same distance apart. Stretch a rubberband across these nails. Make sure the rubberbands are as much alike as possible.

QUESTIONS TO EXPAND SHOULD SUGGEST NEW DIRECTORS, SUCH AS: ANALYSIS OF OTHER POLLUTANTS, ATTEMPTS TO LIMIT OZONE PRODUCTION OR DAMAGE, ETC.

Effects Of Sulfur Oxides

I. Introduction

This activity is to develop an awareness that sulfur oxides are among the pollutants given off when burning fossil fuels and to demonstrate some of the effects of sulfur oxides. It is a jr. high activity and involves observing, comparing, and inferring.

II. Questions

1. To lead to the activity:

   a. What effect can burning oil and coal have on the air?
   b. Why is high sulfur/coal and oil no longer allowed to be burned in many areas?

2. To initiate the activity:

   a. What harmful effects might sulfur oxides have on living things?
   b. What harmful effects might sulfur oxides have on non-living things?
   c. What happens to sulfur oxides when they contact water?

3. To continue and expand the activity:

   a. How do you think sulfur oxides might affect the rain and snow?
   b. Do you think sulfur oxides affect living things?
   c. How could we find out if sulfur oxides affect living things?

4. To evaluate the activity:

   a. Were the students able to perceive the relationship between the experiment and air pollution?
   b. Did the students suggest other materials and methods for testing the effects of sulfur oxides?
   c. Were the students able to state that sulfur oxides in the air may lead to acid rain and snow?
   d. Did any student suggest that we test for acid rain and snow?

III. Equipment

1. 10g/hydrated ferrous sulfate
2. test tubes
3. 1-hole stopper
4. glass bend
5. rubber tubing
6. ring stand and clamp
7. Bunsen burner
8. beaker 1/2 full of cold water
9. magnesium ribbon (1cm)
10. nylon ($1cm^2$)
11. leaf
12. paper and pencils
13. chalkboard and chalk

IV. Procedure

1. In front of class set up ring stand and clamp with test tube containing ferrous sulfate.
2. Connect stopper, glass band, and hose.
3. Put stopper in test tube of ferrous sulfate and end of hose in empty test tube immersed in beaker 1/2 full of cold water.
4. Heat test tube of ferrous sulfate with Bunsen burner.
5. Record observations.
6. Divide collected liquid into 3 test tubes.
7. Put nylon in one test tube, magnesium ribbon in the second, and a leaf in the third.
8. Record observations and compare effects on different materials.
9. Infer what effect burning sulfur-containing fuels might have on the living and non-living parts of our environment.

(note: We could also tie the nylon directly over the end of the hose to find the effect of the gas alone instead of the sulfuric acid)

COULD YOU USE A SEPARATE SECTION OF QUESTIONS "TO EXPAND" TO SUGGEST WAYS IN WHICH TO APPLY YOUR EXPERIMENTAL FINDINGS TO AN ANALYSIS OF ACTUAL ENVIRONMENTAL CONDITIONS?

Schoolyard Air

I. Introduction

This is an awareness exercise for tenth grade biology students.

II. Questions

A. To lead to activity:

1. What is pollution?
2. What types of pollution exist?
3. How does air pollution affect you, relatives, and community?
4. How does air pollution affect the state, country, and world?

B. To initiate the activity:

1. Can you think of any natural causes of air pollution?
2. Can you think of any man made causes of air pollution?
3. What kinds of pollutants can you think of, that have been created by man?
4. What types of fuels cause these pollutants?
5. Are any of these fuels being used to produce energy by power generation companies? Which ones?
6. Do you know of any alternatives to these fuels that are being used or could be used?
7. If these alternative fuels or systems were not available, what if anything could be done to remove or reduce pollutants of the present fuels?

C. To continue the activity:

1. In this section, the students would break into groups to do air pollution studies around the school's campus.
2. Microscope slide smeared with Vaseline to study the different particulates in the air.
3. Use white tissue to remove particulates from leaves to observe the amount of fall-out.
4. Possible SO_2 and ozone samplers.
5. Would you say that our area is relatively pollution free?

D. To expand the activity:

1. What can you, as an individual, do to help cut

down pollution in this area?

E. To evaluate the activity:

1. Do the students perceive what air pollution is?
2. Do the students perceive the different ways in which air is polluted?
3. Do the students perceive the complexities involved in cleaning up the air?

III. EQUIPMENT?

IV. PROCEDURE?

YOUR "CONTINUE" SECTION SHOULD BE DEVELOPED AS QUESTIONS. GIVE THE STUDENTS THE OPPORTUNITY TO "INVENT" THE SAMPLERS THEMSELVES.

Can You See?

I. Introduction

This activity is for students in a first year biology course who are studying the causes and effects of air pollution. It is an awareness activity. (1 class period).

II. Questions

1. To lead to the activity

   a. What are the main objects in the picture?
   b. Are these objects necessary to our way of living?
   c. Why does the city appear to be blurred?

2. To initiate the activity:

   a. By definition, what is smog?
   b. What causes smog?
   c. What are particulates?

3. To continue the activity:

   a. What effects do particulates have on people and their environment?

4. To expand the activity:

   a. How does particulate matter affect the amount of sunlight reaching the surface of the earth?
   b. Can you predict, through reference to the carbon cycle, long term effects of the continued addition of such matter (pollutants) to the air?

5. To evaluate the activity:

   a. Did students understand the long-range effects of particulate matter in the air with regard to green plants and therefore, energy?

III. Equipment

1. Picture from magazine-showing smoke stacks and cars in city covered with a blue haze - smog .
2. Mimeographed carbon cycle - 1 per student.

IV. Procedures

1. Hand picture to a student and tell him to-pass it around the class without any discussion among students.
2. Begin questions and discussion.

WOULD NOT THE REAL ENVIRONMENT PROVIDE A MORE MEANINGFUL EXAMPLE OF AIR POLLUTION AND ITS PROBLEMS?

Production Pollution

I. Introduction

By showing slides and asking questions, the students will become aware of the various methods of electricity generation. and the air pollution associated with those forms of electricity generation.

Questions

1. What are some of the forms of energy?
2. How are these forms of energy used by man?
3. How do you personally use energy? What machines, tools, etc. do you use that need electricity to function?
4. How is electric energy produced? Activity - slides on forms of electric energy production.
5. What forms of air pollution did you note with each method of energy production?
6. What are your feelings about this air pollution?
7. How can air pollution be controlled? Activity - slides on pollution control devices for various plants.
8. Who pays for pollution control?
9. What are your feelings toward the electric companies that pollute the air and produce electricity for your consumption?
10. What are your feelings toward people who waste electricity (leave lights on when not using them, use appliances that can save time, but are not necessary)?

Equipment

1. Slide projector and screen.
2. Slides showing different methods of generating electricity and the air pollution produced by each type of generator.
3. Slides showing air pollution control devices for various electric generating plants.

Procedure

1. Begin with question one. After each question discuss the various answers that develop.
2. At question 5, show slides of different electricity generating methods.
3. At question 8, show slides of different air pollution control devices.

PLEASE ORGANIZE YOUR QUESTIONS (LEAD TO, INITIATE, CONTINUE, ETC.). COULD THE STUDENTS (ON A FIELD TRIP OR AS A HOMEWORK ASSIGNMENT) TAKE THE SLIDES THAT YOU USE?

Air Pollution And Beans

I. Introduction

This activity is an awareness activity for the processes of observing and comparing. The children observe the effects of SO_2 gas on bean plants.

II. Questions

1. Have you ever observed any air pollution effects on plants?
2. Where might the air pollutants come from?
3. What could some of the effects on plants be? Can you make a list?
4. How could we experiment to observe air pollution effects on certain plants?
5. If we put one plant in SO_2 gas and another under normal conditions, can you predict any difference in the growth pattern?
6. How is this experiment related to real pollution conditions from a power plant?
7. What effect do chemicals released into the air have on plants?
8. How is this effect related to the power companies?
9. What can be done to prevent this damage?

III. Equipment

Sulfur, two jars, two bean plants, soil, aquarium, match to ignite sulfur.

IV. Procedure

1. Show a damaged plant if possible.
2. Initiate questions to generate discussion.
3. Plant and germinate two bean seedlings; one for a control.
4. Cover one plant with a large jar or aquarium and burn some sulfur to create SO_2. Expose this plant for a short time.
5. Compare the control, and affected plant for effects of SO_2 gas.

YOUR QUESTIONS NEED FURTHER DEVELOPMENT. THEY SHOULD ALSO BE ORGANIZED AS QUESTIONS TO LEAD TO THE ACTIVITY, TO INITIATE THE ACTIVITY, ETC.

AIR POLLUTION DAMAGES TO VEGETATION CAN BE THE RESULT OF CHRONIC CONDITIONS OR PERIODIC EVENTS. THE RESULTS WILL PROBABLY BE DIFFERENT. YOUR EXPERIMENT SOUNDS LIKE A SINGLE INTENSE EPISODE. MOST SO_2 PROBLEMS OF THE "REAL WORLD" ARE OF A LOW-LEVEL CHRONIC NATURE. COULD YOU ALSO USE THE BEAN PLANTS TO SAMPLE AMBIENT OUTSIDE CONDITIONS?

Energy Can Pollute, Before, During, And After

I. Introduction

This activity is for 11th and 12th grade Physics or Applied Science students. It is an awareness activity, using categorizing, comparing, inferring, and questioning.

II. Questions

1. To lead to the activity:

   a. Are there different forms of energy?
   b. Does the use of energy lead to air pollution?

2. To initiate the activity:

   a. What are the different forms of energy?
   b. What are the primary sources of this energy?
   c. What are the five most commonly used fuels?

3. To continue the activity:

   a. In what ways, if any, does this fuel pollute the air in its production?
   b. In what ways, if any, does this fuel pollute the air in its transportation to the point of its use?
   c. In what ways, if any, does this fuel pollute the air in its use?

4. To expand the activity:

   a. Does this fuel pollute your neighborhood's air?
   b. Can methods be used to eliminate the pollution caused by this fuel?
   c. Who would have to pay for eliminating the pollution?
   d. Can other fuels be used to replace this fuel?
   e. Do you think this other fuel is less polluting than the original fuel?
   f. How would pollution levels be affected if less energy were used?

5. To evaluate the activity:

   a. Could students name the different forms of energy and the fuels that are used to produce them?
   b. Could the students name some of the pollutants?
   c. Did the students realize that ultimately they would have to pay for pollution control?
   d. Did they realize the other fuel was also polluting?

e. Did they understand "pollution level"?

III. Equipment

1. Pencil and paper
2. Reference materials

IV. Procedures

1. The teacher asks entire class Questions 1a and 1b and 2a, 2b, and 2c.
2. The class is divided up into five groups and the students answer question 3 and 4 for one particular fuel.
3. Each group reports its findings to the entire class.

IN WHICH WAYS CAN THIS ACTIVITY BE APPLIED TO AN ANALYSIS OF ACTUAL LOCAL CONDITIONS? ARE THERE ANY PRODUCTION, TRANSPORTATION, OR USE FACILITIES IN YOUR AREA?

TRANSITIONAL LEVEL ACTIVITIES.....

Toilet Tissue Can Help

I. Introduction

This activity is to familiarize students with air pollutants present in their environment. It is for grades 7-9 and of the transitional level.

II. Questions

1. To lead to the activity:

   a. Why do people living in a city need to wash their windows more frequently than someone who lives in the country?
   b. Do trees in the country look healthier than most trees in the city?

2. To initiate the activity:

   a. When coal burns, what are its products?
   b. Which of these products would go up a smoke stack?
   c. Are there other products besides those already mentioned released from smoke stacks of factories that are burning something other than coal?

3. To continue activity:

   Students take a square of white toilet paper and wipe leaves at certain distance intervals from a factory smoke stack.
   a. What types of particles did you find?
   b. What was the relatio ,if any,of the amount and the type of particle to the distance?
   c. Which of the particles do you think came from the smoke stack?

4. To expand the activity:

   Students use a summary table and examine leaves of trees at intervals from the smoke stack to 5 miles away.
   a. From the appearance of the leaves, what pollutants did you identify?
   b. Was there a relation in the frequency of a symptom and the proximity of the stack?
   c. Could you predict any weather conditions from the leaves' symptoms?
   d. Is it possible for a leaf to have a symptom without the pollutant being present?
   e. What do you think a wide variance in growth spurts of a tree could tell you about a factory?

5. To evaluate:

   a. Were students able to collect data properly?
   b. Were students able to evaluate data?
   c. Were students able to read and apply summary chart?
   d. Were students able to form hypotheses?

III. Equipment

1. White toilet tissue
2. Summary of pollutants, sources, symptoms, vegetation affected, injury threshold and chemical analysis.

IV. Procedures:

1. Ask questions (parts 1 & 2).
2. Students take a square of white toilet tissue and wipe leaves of trees at certain intervals from factory smoke stack to 5 miles away. Students keep data charts.
3. Students use summary charts to identify pollutants at intervals from factory stack up to five miles away. Students keep data charts.
4. Initiate questions to generate discussion concerning data.

WHY THE 5-MILE LIMIT? COULDN'T EFFECTS BE FOUND FURTHER AWAY?

LONG- AND SHORT-TERM WEATHER DATA WOULD ALSO BE USEFUL TO YOUR ANALYSIS OF DATA.

Cloth Rot

I. Introduction

This activity is for students, grade levels 10-12. To make them aware of the problem of air pollution and factories and the effect they have on clothing.

II. Questions

1. To lead to the activity:

   a. What does man need to live?
   b. Are any of these things in trouble around here?
   c. What factories affect this?

2. To initiate the activity:

   a. How could we go about checking on trouble areas?
   b. What types of testing would be best?

3. To continue the activity:

   a. How would you go about setting up the field experiment?
   b. What does the data mean?

4. To expand the activity:

   a. What other tests could you do?
   b. What other problems could this pollution cause?

5. To evaluate the activity:

   a. What did the data indicate? Was it reliable?
   b. Did the student understand the relationship between air pollution and clothing?

III. Equipment

1. Clothing scraps
2. Test station
3. Data.

IV. Procedure

1. Break the students into small groups and have them go out and test and collect data.
2. Commence initiation questions to generate discussion.

YOU SEEM TO HAVE IN MIND MORE QUESTIONS THAN YOU WROTE DOWN. PARTICULARLY, QUESTIONS TO GET THE STUDENTS TO DESIGN THE SAMPLERS WOULD BE USEFUL.

Coal-Black Diamond Or Time Bomb

I. Introduction

This activity is designed to introduce the students to some methods of analysis of fuels, in an attempt to predict their impact on the environment. Since coal is the most abundant fossil fuel, the analysis will be for the sulfur content in coal used at a power station.

II. Questions

A. Lead

1. What fuels are used in the production of electric power?
2. Which fuels are the utilities trying to use most often and why?

B. Initiating

1. Why are the utilities being forced to use fuels other than the inexpensive coals?
2. What effects does the sulfur in the coal have on the environment that makes it so objectionable?
3. What are some of the chemical equations to illustrate these effects?

C. Continuing

1. How could these end products be collected and measured?
2. Do you think the utilities use the same methods?
3. Do you think it is possible to determine the amount of pollution-causing sulfur in a fuel without burning the sample and then going through all of the collecting and testing procedures?
4. Using the method outlined in the lab sheet, determine the percent of sulfur in the coal sample given you. How does the figure compare with the air quality limits set by the E.P.A.?

D. Extending

1. Why are the electric companies blamed as being the major pollution in an area?
2. Can you think of any way for these companies to reduce this pollution?
3. Why is moving the power stations not the answer to the pollution problem?

E. Evaluation

1. Were the students able to follow directions to complete the sulfur experiment?
2. Were their results reasonable?
3. Were they able to find any solution to the air pollution problems of the coal-fired power plants?
4. Were the students able to write the chemical equations for the formation of the polluting compounds of sulfur?

III. Equipment

1. Coal sample
2. Normal supplies in a chem. lab.
3. Reference sources for E.P.A. air quality standards.

IV. Procedures

1. Prelab discussion of the effects of sulfur compounds and their formation on the environment.
2. Brief discussion of the methods used in the production of electricity.
3. Retire to Chem. Lab. to perform the procedures for the analysis for sulfur content.
4. Mathematical evaluation of data.

COULD THE TECHNIQUES THE STUDENTS ACQUIRE BE APPLIED TO SAMPLES TAKEN FROM VARIOUS LOCAL GENERATING STATIONS? THAT DATA COULD THEN BE USED IN FUTURE STUDIES OF THE RELATIVE ENVIRONMENTAL CONDITIONS NEAR EACH SITE.

Local Air Survey

I. Introduction

This activity is for 8th grade students familiar with air pollution, but unfamiliar with methods of detection. The purpose of this activity is to give students the opportunity to gather pollution information, process that information, and finally evaluate their information at a transitional level.

The methods would be applied near the students' homes or where the students suspect a pollution source. The tests would last at least one month, at which time the data would be processed and evaluated.

II. Questions

Introduction

1. Why is man concerned about pollution?
2. How does man know that pollution exists?
3. Where would you expect to find the heaviest pollution in this area? (make list)
4. How can we test to detect these (from list) pollutants? (pamphlets and texts available)
5. After a period of data collection, the students have to evaluate their work.

Evaluation

1. What problems did you have gathering your data?
2. Do you need more data?
3. Did the tests indicate the heaviest pollution where you expected it?
4. What is a "control"?

III. Equipment

Pinto beans, planting pots, micro-slides; vaseline*-
(* or fly paper)
Old nylon stockings

IV. Procedures

After introduction questions, the students would be directed to determine where they need to test and what tests they need to make. A period of data collection is established and then the data is brought together on an area map. Finally, the evaluation questions are asked.

SOUNDS LIKE A GOOD DIRECTION, BUT YOUR QUESTIONS NEED FURTHER DEVELOPMENT.

Air Effects

I. Introduction

This activity is for students unfamiliar with the air pollution problems associated with the generation of electricity. It is for the senior high school level. It is a transtitional activity, using data collection.

II. Questions

1. To lead to the activity:

   a. Why is clean air so important?
   b. What diseases can be caused by air pollution?
   c. What other types of damage are caused by air pollution?

2. To initiate the activity:

   a. What are some of the most common air pollutants?
   b. What are the most common sources of these pollutants?
   c. What are the air pollutants involved with generating electricity using oil, coal, and nuclear fuels?

3. To continue the activity:

   a. Which parts of the generating processes created the air pollution?
   b. What substances are responsible for the pollution?

4. To expand the activity:

   a. What are generating plants doing to cut down on air pollution?
   b. Does this have any effect on the cost of electricity?
   c. Who pays for such changes?
   d. What type of power plants are best as far as the aspect of air pollution?
   e. How do these compare with the other types as far as the cost of the electricity produced?

5. To evaluate the activity:

   a. Did the students perceive the problems of air pollution?

b. Did they understand the causes of air pollution in the production of electricity?
c. Did they perceive how changes in technology to cut down on pollutants are related to the cost of electricity.

III. Equipment

1. References on energy and electricity.

IV. Procedures

Students would research the activity on their own with individual assistance. After the allowed research time, discussions would be held concerning the activity.

COULD THIS BE EXPANDED FROM AN IN-CLASS LIBRARY ACTIVITY TO AN ANALYSIS OF THE REAL-LIFE SITUATIONS OR LOCAL POLLUTION, LOCAL EFFORTS TO CURE IT, AND LOCAL COST INCREASES FOR ELECTRICITY?

Would You Like To Live There?

I. Introduction

A transitional activity for senior high school students in industrial arts power technology. The purpose of this exercise is to have students collect information on the various forms of air pollution involved in the production of electric power. From this information, students should draw some conclusions about electric energy production and atmospheric pollution.

II. Activity

Plan a field trip to three types of power generating stations. Prior to the trip, students should be aware of the various forms of atmospheric pollution and how they are measured. What is the environmental impact of these forms of pollution? While on the trip, students should collect the necessary data on each of the various stations. One station will be hydropower, one station will be nuclear power and one station will be a fossil fuel burning steam power plant.

III. Processing

1. Rank in order the plants, in terms of the most to the least air pollution. Record the quantity of air pollutant released by each plant.
2. Select the type of plant you would most like to live next to and explain why.
3. Conversily, select the type of plant you would least like to live next to and explain why.
4. What are some of the environmental impacts you observed at each plant you visited?
5. Which seemed to have the least impact?

THE QUESTIONING APPROACH SHOULD BE USED TO STIMULATE AND MAINTAIN STUDENT INTEREST. COULDN'T THEY BE ALLOWED TO "DISCOVER" FOR THEMSELVES "THE VARIOUS FORMS OF ATMOSPHERIC POLLUTION AND HOW THEY ARE MEASURED"?

OPERATIONAL LEVEL ACTIVITY.....

115

Do Little Power Companies Pollute Too?

I. Introduction

This activity is designed for eleventh grade chemistry students who will have a background in the chemistry of air pollution. They will also have experience in performing chemical tests in the field and in collecting and interpreting raw data. This is an operational activity using the data processing, evaluation and utilization skills.

II. Questions

A. To lead:

1. What are the effects on the air quality of a small local power plant that is fueled by oil?
2. What are the substances produced by the power plant which might be contributing to the air pollution?

B. To initiate:

1. What are the tests that could be performed to determine the levels of common air pollutants such as SO_2 and soot in the air?
2. What equipment will be needed to make these observations and measurements?
3. At which locations, other than at the power plant, should the air contaminants be measured?

C. To continue:

1. What levels of the air contaminants you plan to measure are considered to be acceptable?
2. What are the levels found at non-power plant locations?

D. To expand:

1. What other tests could you perform to determine the levels of other air contaminants?
2. What are the limits of accuracy for the tests you have performed?

E. To evaluate:

1. What levels of air pollutants did you measure near the power plant?
2. What conclusions can you draw from the data you have collected about air pollutants: (a) near the power plant; (b) at sites away

from the plant; and (3) the acceptable standards for this area?

3. What suggestions do you have to remedy any undesirable situations you have observed?

III. Equipment

A. Test kits to collect particulate matter from the air.
B. Test kits to measure content in air samples of common air pollutants.
C. Other equipment requested by the students.

IV. Procedure

A. The students will form groups and set up experimental stations to determine the levels of air pollutants near the Hatfield Borough Electric Department plant and at other locations to provide a control.
B. The students will collect and interpret data on local levels of air contaminants.
C. The students will research the acceptable levels of air pollution in the metropolitan Philadelphia area and the standards set by the Environmental Protection Agency.
D. The students will report on the conclusions they reach and suggest methods of reducing pollution if levels are found to be excessive.
E. They also should be able to make comparisons between the Hatfield Borough Electric plant and larger fossil fueled electric generation plants.

SOUNDS LIKE AN OUTLINE FOR A COMPREHENSIVE UNIT, RATHER THAN A SINGLE CLASS ACTIVITY. YOUR ATTEMPT TO INVOLVE STUDENT INPUT THROUGHOUT LOOKS GOOD.

APPENDIX

Page No.

THE USOE NATIONAL DIFFUSION NETWORK----------A-1

COURSE DESCRIPTION----------A-2

SCHEDULE OF SESSIONS----------A-3

INSTRUCTIONS FOR WRITING ACTIVITIES----------A-5

THE USOE NATIONAL DIFFUSION NETWORK

During 1975-76, Project KARE is operating as a Developer/ Demonstrator Project in the USOE National Diffusion Network. Funding is provided directly from the United States Office of Education (USOE), Washington, D.C., under the Elementary and Secondary Education Act (ESEA) of 1965, Title III, Section 306.

The National Diffusion Network is designed to enhance opportunities for sharing educational success. Components of the network are State Facilitators (SFs), Developer/Demonstrators (D/Ds), and Adoption/Adaption Schools (Adopters). The prime objective of the network is to provide avenues for SFs, D/Ds, and Adopters to interrelate such that educational expertise of D/Ds is transmitted to the Adopters. That which is transmitted might consist of processes, materials, or skills.

Project KARE, beginning in 1971, developed a process for strengthening environmental studies in local schools. Learning materials including "curriculum activities guides" were produced. Skills for implementing the KARE Approach are being achieved by teachers, administrators, students, and community leaders who participate in KARE training workshops. All project activities were carefully evaluated by an independent evaluator, ERANDA, Inc., of West Chester, Pennsylvania. During Spring, 1975, Project KARE participated in two national procedures which assay effectiveness and exportability of innovative educational programs. In June, the project was "validated" by the Pennsylvania Department of Education and USOE as a successful, exemplary educational practice worthy of widespread dissemination. Concurrently, Project KARE was "certified" by the Joint Dissemination Review Panel of USOE and the National Institute of Education as an educationally-sound innovation verified by accepted evaluation procedures.

Accordingly, Project KARE was selected and funded by USOE as a Developer/Demonstrator Project. As such, the project is required to provide a majority of services to local education agencies outside Pennsylvania. In addition to conducting training workshops, the project is producing and disseminating various curricular and awareness materials, and maintaining demonstration schools for on-site visitations by potential Adopter schools.

The role of State Facilitators is to assist Adopter schools in determining educational needs; to disseminate relevant information to local schools about successful programs in the network; and to monitor the installation, operation, and assessment of successful adoptions. Thus, the State Facilitator provides assistance to match potential Adopter schools with Developer/Demonstrators. In Pennsylvania, Project RISE, King of Prussia, serves as State Facilitator.

COURSE DESCRIPTION:
ELECTRIC POWER GENERATION AND THE ENVIRONMENT

This workshop is co-sponsored by Project KARE, the Montgomery County Science Teachers Association, the Philadelphia Electric Company and the Intermediate Unit. The workshop will expose elementary and secondary teachers to: 1) the complexities of energy production and utilization; 2) the governmental and scientific aspects of the siting of electric power generating plants and the monitoring of environmental factors which bear upon ecosystems; 3) the actual locations of power generating stations and of the research facilities geared to environmental monitoring through field trips; 4) the methods of building into the school curriculum certain techniques and information relevant to the topic of power generation and the environment. On site visitations will be conducted to the Pennsylvania, New Jersey, and Maryland Power Grid Dispatch Center, King of Prussia, Icthyological Associates, Pottstown; Limerick Generating Station; and an all day field trip to Conowingo Dam, Research Laboratories on the Susquehanna River, and the University of Delaware Solar House.

June 23 - 27, 1975 9:00 A.M. to 12:00 Noon and 12:30 P.M. to 3:30 P.M.

LIMERICK GENERATING STATION INFORMATION CENTER, LIMERICK, PA., AND FIELD TRIP LOCATIONS

Instructors: Ronald Harper, Philadelphia Electric Co.;
Alan Sexton, Project KARE;
Paul Harmon, Icthyological Associates;
John Kostige, Mont. Co. Science Teachers Assoc.

TWO CERTIFICATION CREDITS Min. No. 20 Max. No. 45 FEE: $20

ELECTRIC POWER GENERATION AND THE ENVIRONMENT

Schedule of Sessions

June 23 - June 27, 1975

DATE	TIME	SUBJECT	PLACE
June 23 (Monday)	9:00-10:30	Energy Dilemma R.L. Harper, PECo.	Limerick AIC
	10:30-12:00	Consumerism KARE	Limerick AIC
	12:30-1:30	Fossil Fuel Gen. W. Alden, PECo.	Limerick AIC
	1:30-2:30	Nuclear Gen. W. Alden, PECo.	Limerick AIC
	2:30-3:30	Alternate Sources G. Hunger, PECo.	Limerick AIC
June 24 (Tuesday)	9:00-10:30	Nuclear Safety & Licensing H.L. Bermanis, U.E. & C.	Limerick AIC
	10:30-12:00	Radiation Steve Kim	Limerick AIC
	12:30-1:30	Radiation Monitoring Steve Kim	Limerick AIC
	1:30-2:30	Air Monitoring KARE	Limerick AIC
	2:30-3:30	Water Monitoring KARE	Limerick AIC
June 25 (Wednesday)	8:30-12:00	Field trip to PJM and Cromby	Meet bus at Limerick AIC
	12:00-3:00	Field exercise-Schuylkill River (IA & KARE)	
June 26 (Thursday)	8:00-5:00	Field trip to Conowingo Station and IA Laboratories and U. of Delaware Solar House	Meet bus at Limerick AIC

DATE	TIME	SUBJECT	PLACE
June 27 (Friday)	8:30-10:00	Limerick Site Visitation	Limerick AIC
	10:00-11:00	Panel Discussion Topic: Alternative Sources of Energy Panel includes student representatives of Colonial School District and representatives of Green Valley Assoc., Project KARE, and Philadelphia Electric Co.	
	11:00-12:00	Evaluation	

KARE - Knowledgeable Action to Restore Our Environment
MCIU - Montgomery County Intermediate Unit
IA - Ichthyological Associates
AIC - Atomic Information Center
PECo. - Philadelphia Electric Company
U.E.&C. - United Engineers and Constructors.

INSTRUCTIONS FOR WRITING ACTIVITIES

When designing environmental studies activities, one must take into account the level of experience and understanding of the participants. Accordingly, three levels of activities have been developed.

Awareness activities allow participants to make observations and draw conclusions about real things in their environment. Transitional activities deal with concern and/or interests that have grown out of awareness activities. These activities allow groups to focus on problems which have been defined and which are successfully dealt with within the existing school time structure. Transitional activities lead to operational activities, which consist of complex problem investigations that may not be fully completed during a formal course of study.

Awareness and transitional activities are presented in a question-oriented format. This approach was chosen because it allows students to respond as individuals; because it diminishes the authority-figure role of the teacher; and because it implies that there are few if any ultimates which can be applied to real world situations. By using this format, we are not implying that anyone can pick up a printed activity, ask the sample questions and expect the specific activity to magically follow. Individual teachers may have to formulate their own questions to guide their students. No special format is used for operational activities. Generally, a process is described and then the participants become involved with an environmental situation using the process. A simulation developed by KARE, REPS (Realistic Environmental Problem Simulation), represents one such process.

Five categories of questions are used to involve the co-learners in activities. Questions which lead to the activities are intended to direct thinking toward a general area of investigation. Those to initiate require action if they are to be answered. Questionsto continue help to give the problem more definition. Questions to expand allow branching-off points and suggest areas of further investigation. Those which are used to evaluate help the co-learners to assess successes and failures and to determine progress.

Activities should be developed with process skills in mind. The purpose of a process-oriented development is to set the basis for student-initiated activities. Students will be better able to deal with investigations of their own design if they have had previous experience with process skills.

The process skills are divided into levels which parallel those

of the activities. They are as follows:

1. Awareness level
   a. observing
   b. categorizing
   c. comparing
   d. measuring
   e. inferring
   f. questioning

2. Transitional level
   a. predicting
   b. data collection
   c. data processing
   d. data evaluation
   e. formulation of hypotheses

3. Operational level
   a. problem recognition and definition
   b. problem analysis
   c. data processing
   d. data evaluation
   e. data utilization

Reference: Sparks, P.M., Sexton, A.D., et al, A Curriculum Activities Guide to Solid Waste and Environmental Studies, Institute for Environmental Education, Cleveland, Ohio. 1973